

HARFORD COUNTY
DEPARTMENT OF PUBLIC WORKS
ROADWAY & STORMDRAIN
DESIGN STANDARDS

MAY 1, 2007

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Section I	Roadway Design Standards
Section II	Stormdrain Design Standards
Appendix I	Roadway Design Tables/Charts
Appendix II	Stormdrain Design Tables/Charts
Appendix III	Standard Abbreviations and Symbols
Appendix IV	Roads and Stormdrain Review Check List
Appendix V	Rules and Regulations for Road Access Permits
Appendix VI	Rules and Regulations for Utility Construction Permits
Appendix VII	2004 AASHTO Intersection and Stopping Sight Distances (reference only)

**HARFORD COUNTY
DEPARTMENT OF PUBLIC WORKS
ROADWAY DESIGN STANDARDS**

SECTION I

HARFORD COUNTY DEPARTMENT OF PUBLIC WORKS ROADWAY DESIGN STANDARDS

I.	DEFINITIONS	R-1
II.	GENERAL.....	R-7
A.	Introduction.....	R-7
B.	Waivers	R-7
C.	Philosophy of the Design Manual - Professional Creativity.....	R-7
1.	Capital Projects	R-7
2.	Development Projects	R-8
D.	Roadway Classification	R-8
1.	Interstate.....	R-8
2.	Parkway.....	R-8
3.	Arterial	R-8
a.	Urban Principal Arterial.....	R-8
1)	Freeway and Expressway.....	R-8
2)	Other Urban Principal Arterial	R-8
b.	Urban Minor Arterial	R-8
c.	Rural Principal Arterial.....	R-8
d.	Rural Minor Arterial	R-8
4.	Collector.....	R-8
a.	Urban Collector.....	R-8
b.	Rural Major Collector	R-9
c.	Rural Minor Collector.....	R-9
5.	Local	R-9
a.	Business District Roads	R-9
b.	Residential Road Classifications	R-9

1)	Residential Collectors	R-9
2)	Residential Sub-collectors	R-10
3)	Residential Access Streets	R-11
4)	Town House Access.....	R-13
III.	ROADWAY/TRAFFICWAY DESIGN	R-14
A.	Preliminary Considerations.....	R-14
B.	Determination of the Typical Section	R-14
C.	Modification of Typical Section or Design Criteria	R-14
D.	Intersection Criteria	R-15
1.	Intersections of County Roads	R-15
2.	Intersections with State Roads	R-16
3.	Residential/Commercial/Industrial Entrances (Driveways)	R-16
4.	Auxiliary Lanes.....	R-17
a.	Deceleration Lanes	R-17
b.	Left-Turn Lanes	R-17
c.	Acceleration Lanes	R-18
E.	Sight Distance	R-18
1.	Stopping Sight Distance.....	R-18
2.	Intersection Sight Distance	R-18
a.	New Intersections within a Subdivision	R-19
b.	New Intersections with Existing County Roads	R-19
F.	Cul-de-sacs/ Temporary Tee Turn-Arounds	R-20
1.	Cul-de-sacs.....	R-20
2.	Temporary Tee Turn-Arounds	R-20
G.	Road End Signing	R-21
H.	Maintenance of Traffic Plan	R-21
I.	Alleys	R-21
J.	Bus Stops	R-21
IV.	GEOMETRIC DESIGN	R-23
A.	County Roads Excluding Town house Roads.....	R-23

1.	Horizontal Alignment	R-23
a.	Horizontal Curves	R-23
1)	Design Speed Minimum Radii.....	R-23
2)	Curve Data	R-23
3)	Minimum Curve Length	R-23
4)	Reverse Curves	R-23
5)	Compound Curves	R-23
6.	Curve Widening	R-23
b.	Driveways/Panhandles.....	R-24
c.	Commercial and Industrial Entrances.....	R-24
d.	Intersection Geometry.....	R-25
e.	Special Design Elements	R-25
1)	Roundabouts	R-26
2)	Monumental Entrances	R-26
3)	Divided Roadways.....	R-27
a)	Residential Divided Roadways.....	R-27
b)	Commercial Divided Roadways	R-27
2.	Vertical Alignment	R-28
a.	Grades	R-28
1)	Minimum Grade.....	R-28
2)	Maximum Grade	R-28
3)	Profile Grade Line	R-28
b.	Intersection Criteria	R-28
1)	Intersection with County Roads.....	R-28
2)	Intersections with State Roads.....	R-29
c.	Vertical Curves	R-29
1)	Use of a Vertical Curve	R-29
2)	Design	R-29
3)	General Controls	R-30
d.	Linear Profiles.....	R-30
1)	Minimum Grade.....	R-30
2)	Minimum Curve Length	R-30
e.	Super-Elevation and Transitioning	R-30
B.	Town House Roads.....	R-31
1.	Horizontal Alignment	R-31
2.	Vertical Alignment	R-31
3.	Cross Slope:	R-31

4.	Perpendicular Parking	R-31
V.	TREES WITHIN THE COUNTY RIGHT-OF-WAY.....	R-33
A.	General.....	R-33
B.	Existing Trees and Forests	R-33
1.	General.....	R-33
2.	Location	R-34
C.	Planted Trees and Forests	R-34
1.	General.....	R-34
2.	Location	R-34
3.	Street Trees and Grouped Plantings.....	R-35
D.	Tree Selection	R-35
E.	Recommended Tree List	R-37
VI.	TYPICAL SECTION.....	R-39
A.	Paving Section	R-39
B.	Curb and Gutter	R-39
C.	Permanent, Non-Breakaway Structures in the Right-of-Way	R-39
D.	Traffic Barriers	R-39
E.	Sidewalks/Sidewalk Ramps	R-40
F.	Side Slopes.....	R-41
G.	Shoulders	R-41
H.	Islands and Medians.....	R-41
I.	Bikeways.....	R-41

J.	Signing and Striping	R-42
K.	Street Lights	R-42
1.	County Intersections	R-42
2.	State Highway Intersections	R-42
L.	Roadside Swales/Ditches	R-43
M.	Utility Location	R-43
N.	Cross Sections and Quantities	R-43
O.	Under-drain	R-43
P.	Right-of-Way Width	R-43
VII.	CONTRACT DRAWINGS	R-44
A.	Preliminary Reports	R-44
B.	Contract Drawings	R-44
1.	General	R-44
2.	Title Sheet	R-44
3.	Plan	R-44
a.	General	R-44
b.	Street Names	R-44
c.	Widths of Right-of-Way, Pavement and Easements	R-45
d.	Topography	R-45
e.	Coordinates and Bearings	R-45
f.	Horizontal Curve Information	R-45
g.	Stationing	R-46
h.	Match Lines	R-46
i.	Points of Intersection of Curb Lines	R-46
j.	Direction of Drainage	R-46
k.	Storm Drainage	R-47
l.	Grading	R-47
4.	Profiles	R-47

a.	General.....	R-47
b.	Profile Grade.....	R-47
c.	Previously Established Top of Curb Grade and Centerline Grade	R-47
d.	Existing Ground Profiles at Centerlines and Property/Right-of- Way Lines	R-47
e.	Vertical Curves	R-48
f.	Top of Curb Grades for Cul-de-sacs:.....	R-48
g.	Top of Curb Grade of Intersecting Streets.....	R-48
h.	Stationing and Elevations	R-48
i.	Extension of Profiles.....	R-49
j.	Profiles of Alleys and Entrances to Parking Areas.....	R-49
5.	Typical Sections.....	R-49
6.	Cross Section	R-49
7.	Check List	R-49
8.	Stakeout and Grade Sheets	R-50
C.	Contract Specifications	R-50
D.	Estimate of Quantities.....	R-51
E.	Design Calculations	R-51
F.	Temporary Easement Plats	R-51

SECTION I

ROAD AND STREET DESIGN STANDARDS

I. DEFINITIONS

The terms as used in this manual shall conform to the definitions in the Harford County Department of Planning and Zoning's "Subdivision Regulations" and Harford County "Specifications for Construction and Materials". Additional terms used in this manual are as follows:

AASHTO: American Association of State Highway and Transportation Officials - Policy on Geometric Design of Highways and Streets, current edition (unless otherwise noted).

ADAAG: Americans with Disabilities Act Access Guidelines, current edition.

ALLEY: A private roadway that provides access to the side or rear of individual land parcels.

APPROACH NOSE: An end of an island, or area between diverging roadways, which faces approaching traffic passing to one or both sides.

AVERAGE DAILY TRAFFIC (ADT): The typical daily traffic volume on a roadway wherein volumes are counted on a non-holiday week on Tuesday, Wednesday, or Thursday.

CLEAR ZONE: The traversable distance from the traveled way to the nearest obstruction available for safe use by errant vehicles. The grade must be equal to or flatter than a four to one (4:1) slope.

CLOSED SECTION ROAD: A roadway in which curb and gutter is installed to contain and control the flow of stormwater to a location where there is a suitable outfall - generally through the use of an underground storm drain system.

CONSTRUCTION AND CONSTRUCTED: Includes construction, rehabilitation, and reconstruction, but shall not include maintenance.

CONTRACTOR: The person, partnership, firm, corporation or joint venture undertaking the execution of the work under the terms of the Contract acting directly or through his, their, or its agents or employees.

CURB RAMP: An inclined access opening along the curb line at which point pedestrians: unassisted or assisted by wheelchair, walker or the like; may enter or leave the street from or to a sidewalk.

CULVERT: Any structure not classified as a bridge which provides an opening under any roadway.

DEDICATION PLAT: Any plat conforming to law, duly recorded among the land records of Harford County, which has the legal effect of dedicating one or more rights-of-way and/or easements to public use.

DEPARTMENT OF PUBLIC WORKS: The Harford County Department of Public Works as established in conformance with the laws of Harford County, per Charter and Code.

DESIGN SPEED: The maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern. The design speed for new roads is as identified in Table 1 in the Appendix of this document. For existing roads, wherein new intersections or road geometrics are being proposed; the designer shall use the operating speed of the roadway in their analysis and calculations (see definition on operating speed). For roads that were newly constructed since 1980, the design speed on the original plans may be presented to the County for review and consideration. If, upon review by Harford County, the road's character, volumes, safety, etc. has changed since the original design, then the County may require the engineer utilize the operating speed of the highway in lieu of the original design speed due to changed site conditions.

DEVELOPER: The person, partnership, corporation, or joint venture undertaking the improvement and/or subdivision of land.

DIRECTOR: The Director of the County Department of Public Works and his duly authorized agents, per Charter and Code.

DRAINAGE DITCH: Any open water course constructed as indicated in Contract Documents.

DRAINAGE STRUCTURE: Includes culvert, bridge, storm sewer, inlet, canal, ditch, subsurface drain and any structure or watercourse designed to carry off surface or other waters.

DRIVEWAY: A private road giving access from a public way to a building on adjacent property.

EMBANKMENT: A structure of soil, soil aggregate or broken rock that provides lateral support of the roadway structure or aids in defining channelized drainage courses.

EMBANKMENT FOUNDATION: The material below the original ground surface, the physical characteristics of which affect the support of the embankment.

FEDERAL/STATE AGENCY: Reference to any Federal or State agency or officer shall be deemed made to any agency or officer succeeding in conformance with law to the powers, duties, jurisdictions and authority of the agency or officer mentioned.

FLEXIBLE PAVEMENT: A pavement structure which maintains intimate contact with and distributes loads to the sub-grade and depends upon aggregate interlock, particle friction, and cohesion for stability.

GRADE: The rate of ascent or descent of a roadway, stormdrain pipe or channelized drainage course; expressed as a percent; the change in the elevation per unit of horizontal length.

GRADED SHOULDER: The portion of a road bed contiguous with the travel way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses. The surface of shoulder shall be grass.

HEADLIGHT SIGHT DISTANCE (MINIMUM): The headlight sight distance conforms to the minimum stopping distance definition; based on the length of the roadway along an under-vertical (sag) curve illuminated by headlights two (2) feet above the traffic way with a one (1) degree divergence of the light beam from the vehicle's longitudinal axis.

INSPECTOR: A representative of the Director authorized to make any or all necessary inspections of work performed and material furnished by the Contractor or Developer.

INTERSECTION SIGHT DISTANCE: The distance required to safely negotiate an intersection when entering from a lower priority street. Appendix VII of this code contains the sight distance requirements from the AASHTO Geometric Design Policy for grades up to and including three (3) percent for the priority road (grades greater than three (3) percent shall refer directly to the AASHTO Geometric Design Policy). In the event an updated AASHTO Geometric Design Policy is released and the distance requirements are revised, the most recent version of AASHTO shall take precedence over the distances stipulated in this code.

MEDIAN: The portion of a divided street separating the traveled ways for traffic in the opposite directions.

M.U.T.C.D.: The Federal Highway Administration's "Manual on Uniform Traffic Control Devices", current edition.

OPERATING SPEED: The speed which most closely equals the travel desires and habits of nearly all drivers on an existing segment of road. This speed is most often defined as the eighty-fifth (85th) percentile speed. When the eighty-fifth (85th) percentile speed is not available, the design engineer may either establish it to be ten (10) miles per hour (MPH) over the posted speed limit or perform a speed study utilizing approved traffic engineering practices and submit the results for approval to the County. On residential sub-collectors and residential access streets, the posted speed limit will be considered to be the operating speed for all intersection sight distance calculations and the posted speed limit plus five (5) miles per hour (MPH) will be considered to be the stopping sight distance.

OPEN SECTION ROAD: A roadway in which there is no curb and gutter installed and stormwater sheet flows off of the road into a drainage ditch.

PAVEMENT STRUCTURE: The combination of sub-base and/or base course and surface course placed on a sub-grade to support and distribute the traffic load to the roadbed.

PEDESTRIAN: A person traveling on foot.

PERMITTEE: A person, firm or corporation who has applied for and holds a valid permit in full force and effect, issued by the Director of the Department of Public Works, authorizing construction in a public right-of-way.

PERPENDICULAR PARKING PADS: A row of parking spaces (not driveways) immediately contiguous, and at right angles, to the paved surface of a road - typically found in town house subdivisions.

PERSON: Any individual, association, firm, partnership, corporation but does not include governmental agency, whether County, Federal, State or Municipal.

PLANS: The official drawings approved by the Harford County Department of Public Works as part of the Contract Documents, including those incorporated in the Contract Documents by reference. These include the official plans, profiles, typical cross sections, working drawings, and supplemental drawings or exact reproduction thereof which show the location, character, dimension, and details of the work to be done and which are considered as a part of the contract supplementary to these specifications and which are identified as such.

PRIORITY ROAD: At an intersection, the roadway having the higher roadway classification or at an intersection of roads with the same classification, the road carrying the higher existing or projected volumes of traffic.

PROFILE GRADE: The trace of a vertical plane intersecting the top surface of the proposed wearing surface usually along the longitudinal centerline of the roadway. Profile grade means either elevation or gradient of the vertical plane.

PUBLIC WORKS AGREEMENT (PWA): An agreement between the County and the Developer to ensure the completion of construction of any given project.

RIGHT-OF-WAY: A general term denoting land, property, or interest therein, usually a strip, acquired for or devoted to transportation purposes. The area which has been acquired and reserved by the County for use in constructing and improvement and appurtenances thereto.

ROAD, HIGHWAY, ROADWAY, TRAFFICWAY: Rights-of-way, surfaces, sub-grades, shoulders, median dividers, drainage facilities and structures, roadway cuts, roadway fills, traffic barriers, bridges, overpasses, underpasses, interchanges, approaches and other structures forming an integral part of a street, road or highway; including bicycle and walking paths and related stormwater management facilities and structures or any other property acquired for the construction, operation or use of the highway.

ROAD, PRIVATE: A roadway that shall not receive County maintenance, but shall be owned and maintained by the owners of the property adjacent to the roadway.

ROAD, STATE: Any public road included in the Maryland State Highway system.

ROAD, TOWN HOUSE: A County maintained access road in a fee simple town house subdivision.

ROAD SPECIFICATIONS: The abbreviated title for the Harford County specifications utilized to construct public improvements.

ROADBED: The graded portion of a road within top and side slopes, prepared as foundation for pavement structure and shoulder.

ROADSIDE: A general term denoting the area adjoining the outer edge of the roadbed within the right-of-way. Extensive areas between the roadways of a divided highway may also be considered roadside.

ROADSIDE DEVELOPMENT: Work for the preservation of natural and landscaped areas and the rehabilitation and protection against erosion of all areas disturbed by the construction through seeding, sodding, mulching, and placing of other ground covers; suitable planting, and other improvements to increase the effectiveness and enhance the appearance of the highway.

SHOULDER: The portion of a roadbed contiguous with the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

SIDEWALK: That portion of the roadway primarily constructed for the use of pedestrians. Sidewalks shall be concrete and located one foot away from the right-of-way line, unless otherwise noted.

SLOPES: The inclined graded area beyond the shoulder and extending from the shoulder to the natural undisturbed surface of the ground.

STOPPING SIGHT DISTANCE: The distance a vehicle travels from the instant that a driver sights an object necessitating a stop to the instant the brakes are applied, plus the distance required to stop the vehicle after the brakes have been applied. Appendix VII of this code contains the sight distance requirements from the AASHTO Geometric Design Policy for grades up to and including three (3) percent for the priority road (grades greater than three (3) percent shall refer directly to the AASHTO Geometric Design Policy). In the event an updated AASHTO Geometric Design Policy is released and the distance requirements are revised, the most recent version of AASHTO shall take precedence over the distances stipulated in this code.

STRUCTURE: Bridges, culverts, inlets, drop inlets, retaining walls, cribbing, manholes, end walls, buildings, sewers, service pipes, under-drains, foundation drains, steps, fences and other features which may be encountered and not otherwise classed.

SUB-BASE: The layers of specified or selected material of designed thickness placed on a sub-grade to support a base course or a surface course; to accommodate the traffic load.

SUB-GRADE: The top surface of a roadbed upon which the pavement structure, shoulders, and curbs are constructed.

SUBSTRUCTURE: All of that part below bottoms of bearings of simple and continuous spans, skew-backs of arches and tops of footings of rigid frames, together with back-walls and wing-walls.

SUPERELEVATION RATE: The rate of rise in cross section of the finished surface of a roadway on a curve, measured from the lowest or inside edge to the highest or outside edge.

SUPERSTRUCTURE: All of that part of a structure above bottoms of bearings of simple and continuous spans, skew-backs of arches and tops of footings of rigid frames, except as noted above for sub-structure.

SURFACE COURSE: One or more layers of a pavement for a smooth impervious surface.

TRAVELED WAY: The portion of the roadway used for the exclusive movement of vehicles, exclusive of shoulders.

TRENCH: An excavation made for the purpose of installing or removing pipes, drains, inlets, construction foundation structures, etc. and which is later refilled.

II. GENERAL

A. Introduction

The transportation system is the major structural element of the rural-suburban-urban community. In many instances, it dictates the shapes and elements of the various land uses in the community. Roads are the principal elements of the transportation system. It is extremely important that roads be planned and coordinated in conjunction with the zoning plan for a given area. Roads are permanent improvements and are expensive to construct and maintain. Therefore, the greatest care and foresight are needed in the development of plans for roads so they will be adequate to meet the needs of the developing community at an acceptable level of service and be economical to maintain.

B. Waivers

In unusual circumstances, deviations from the criteria contained in this manual may be warranted. In such cases, a formal application for a waiver shall be submitted to the Project Engineer subject to the approval of the Director or his duly authorized agent.

C. Philosophy of the Design Manual - Professional Creativity

The underlying philosophy of this manual is to provide a framework within which the experienced professional engineer will have latitude for creativity in the layout and design of the road systems and their various components. The manual establishes the minimum design requirements. The engineer is encouraged to use professional skill, experience, and judgment to develop the most feasible and practical design for the planned facility.

Final determination concerning a development project with respect to road issues (i.e. classification) will be made by the Harford County Department of Planning and Zoning and the Harford County Department of Public Works, in accordance with the Department of Planning and Zoning's "Transportation Plan - An Element of the Harford County Master Plan" and the Development Regulations Manual. However, the actual road design is subject to final traffic study recommendations for the roadway width, number of lanes, and channelization due to specific traffic volume projections.

Drawings and documents for Public Works Projects shall be prepared in accordance with instructions contained in this manual and shall be classified as follows:

1. Capital Projects

Capital Projects shall be considered as those projects where the subdivision of property is not primarily involved. These projects are initiated through the Department of Public Works and shall be designed in accordance with criteria established by the Department of Public Works.

2. Development Projects

Development Projects shall be considered to be those projects where the subdivision of property is primarily involved or where the development of a site requires road and utility improvements. The improvements as required under the Harford County Planning and Zoning's "Subdivision Regulations" and Adequate Public Facilities legislation are processed with the roads and utilities designed in accordance with criteria established by the Department of Public Works.

D. Roadway Classification

The basic functions of all roads are the movement of vehicular traffic and the provision of access to adjacent land. The Harford County Highway Classification System is exclusively based on these functions and divides the components of the overall road system into various roadway classifications, each serving the two basic functions to different degrees. These classifications are based on general plan guidelines and design data developed from alignment studies and/or traffic studies. The roadway classifications and their characteristics are as follows:

1. Interstate

As defined by the Harford County Department of Planning and Zoning's "Transportation Plan; an Element of the Harford County Master Plan".

2. Parkway

As defined by the Harford County Department of Planning and Zoning's "Transportation Plan; an Element of the Harford County Master Plan".

3. Arterial

As defined by the Harford County Department of Planning and Zoning's "Transportation Plan; an Element of the Harford County Master Plan"; broken down into the following categories and sub-categories:

- a. Urban Principal Arterial
 - 1) Freeway and Expressway
 - 2) Other Urban Principal Arterial
- b. Urban Minor Arterial
- c. Rural Principal Arterial
- d. Rural Minor Arterial

4. Collector

As defined by the Harford County Department of Planning and Zoning's "Transportation Plan; an Element of the Harford County Master Plan"; broken down into the following categories and sub-categories:

- a. Urban Collector

- b. Rural Major Collector
- c. Rural Minor Collector

5. Local

Harford County's Department of Public Works further categorizes local roads as Business District Roads and Residential Roads. Note that all developer constructed new roads will fall into one of the following local road categories unless otherwise specifically defined in the Department of Planning and Zoning's Preliminary Plan Approval Letter.

a. Business District Roads

A Business District Road is one that provides one or more of the following:

- 1) Interconnection between highly developed commercial or industrial property to arterial roads,
- 2) Access to individual properties comprising a commercial/industrial complex, and/or
- 3) Carries heavy volumes of truck traffic within or adjacent to any land which has been approved for any class of commercial or industrial use.

The typical section for a Business District Road shall be a forty (40) foot closed section road on a sixty (60) foot right-of-way. Sidewalks five (5) feet in width shall be provided along both sides of the roadway.

b. Residential Road Classifications

Residential roads shall be classified as residential collectors, residential sub-collectors, residential access streets, and town house access roads. The design standards for the classifications of the residential roads are based on the lot sizes of the developments and the amount of daily traffic the road is expected to carry.

1) Residential Collectors

Residential collectors are streets that collect and distribute traffic between residential sub-collectors and provide the linkage to streets of a higher classification. Residential collectors should be designed with no or limited residential accesses and no on-street parking. Direct access, if permitted, shall be restricted to lots with a minimum of one hundred (100) feet of frontage. The lots must provide sufficient parking for two (2) vehicles and a turnaround so vehicles will not have to back out onto the collector streets. Additionally, the number of lots permitted to front on residential collectors shall be restricted to the limits as stated in the chart below.

PERMITTED TOTAL NUMBER OF ACCESS POINTS

ON A RESIDENTIAL COLLECTOR

ADT	1,251-1,499	1,500-1,799	1,800-1,999	2,000+
ALLOWABLE NUMBER OF ACCESSES PER 1000*	8	4	2	0

*Distance measured along the centerline of the road.

Design standards for residential collectors shall be dependant upon the type of development it is servicing.

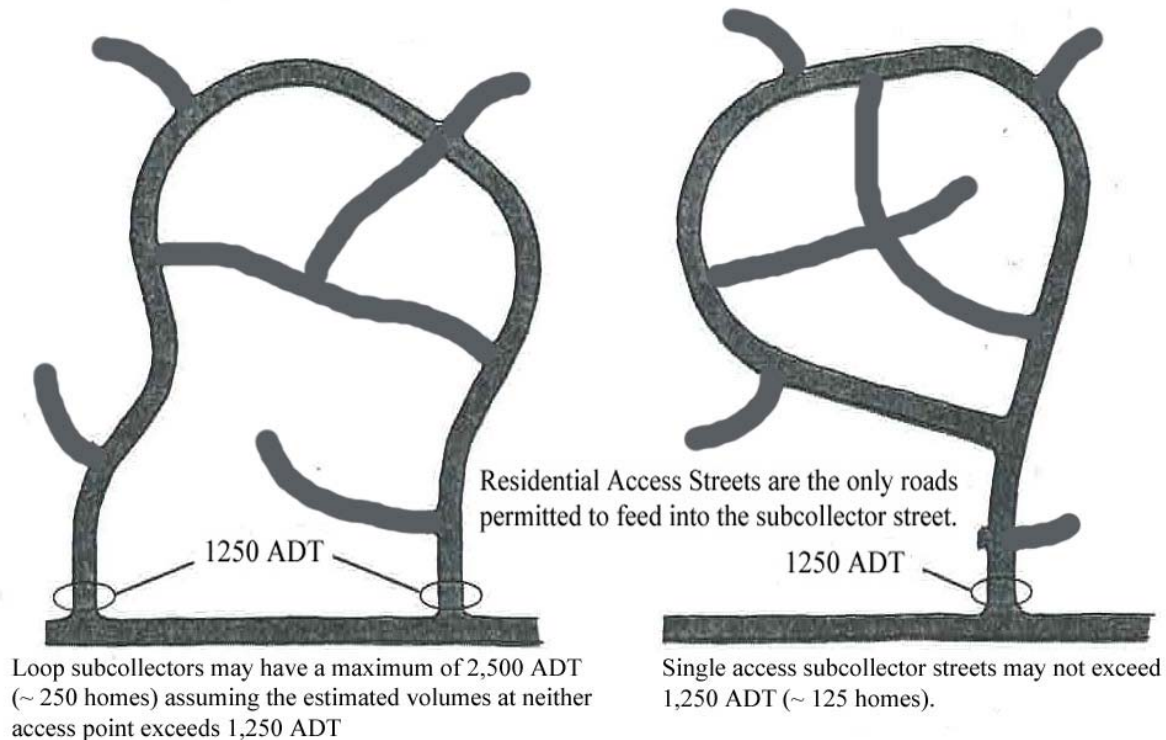
A residential collector shall be designed as a twenty-four (24) foot open section road on a sixty (60) foot right-of-way with a six (6) foot graded shoulder, drainage ditch, and a four (4) foot wide sidewalk along one side on the outside of the drainage ditch, or a twenty-four (24) foot wide, closed section road on a fifty (50) foot right-of-way with a four (4) foot wide sidewalk on one side of the road when servicing neighborhoods with lots greater than 20,000 square feet.

A residential collector shall be designed as a thirty (30) foot closed section road with mountable curbs and five (5) foot wide sidewalks on both sides of the roadway, situated on a fifty (50) foot right-of-way where it services communities with lots less than 20,000 square feet, or where it is connected to a neighborhood requiring closed section roads for sub-collectors and access streets.

The residential collector (open and closed section) shall be widened to a thirty-six (36) foot width at the entrance to the community. This widening shall only occur on the outbound approach to the intersection, extend a minimum distance of one hundred (100) feet and taper at a ten to one (10:1) ratio to the aforementioned road section.

2) Residential Sub-collectors

Residential Sub-collectors are local streets that provide frontage for residential lots and may carry some residential through traffic from access streets. A residential sub-collector shall be designed so that the amount of traffic for any section will carry no more than 1,250 ADT. The design of the sub-collector shall be determined by the type of neighborhood it is servicing.



A sub-collector road serving lots greater than or equal to 30,000 square feet shall be designed as a twenty-four (24) foot closed section road with mountable curb, on a fifty (50) foot right-of-way with four (4) foot wide sidewalks on at least one side of the road.

A sidewalk/hard surfaced trail system with a minimum width of five (5) feet and interconnecting all of the lots may be considered in lieu of the traditional sidewalk provided that it is child stroller and wheelchair accessible and no grades are steeper than the street grades within the subdivision.

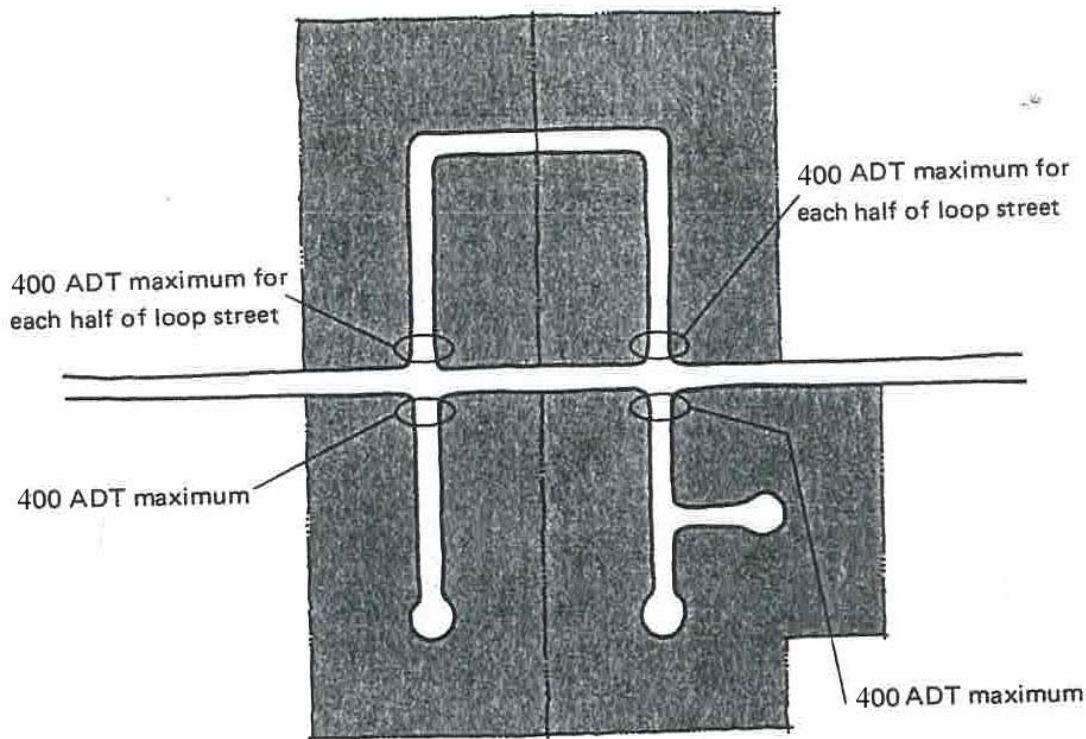
For communities with lots between 10,000 square feet and 30,000 square feet, a sub-collector shall be designed as a thirty (30) foot closed section road with mountable curb and five (5) foot wide sidewalks on both sides of the street on a fifty (50) foot right-of-way.

A sub-collector shall be designed as a thirty-six (36) foot closed section road with mountable curbs and five (5) foot wide sidewalks on both sides of the street on a sixty (60) foot right-of-way for communities with lot size less than or equal to 10,000 square feet.

When connecting to roads classified as a county collector or higher, residential sub-collectors shall be thirty-six (36) feet wide from the intersection for a minimum distance of one hundred (100) feet. The widening shall only occur on the outbound approach to the intersection and shall taper at a ten to one (10:1) ratio to the required standard section.

3) Residential Access Streets

Residential Access Streets provide frontage and access to residential lots. The access streets are designed to provide access only to the lots fronting on it, which will eliminate through traffic. A residential access street shall carry a maximum of 400 ADT.



The design of residential access streets shall also be determined by the type of neighborhood it is servicing.

For communities with lot sizes greater than or equal to 30,000 square feet, an access street shall be designed as an eighteen (18) foot open section road on a fifty (50) foot right-of-way with six (6) foot graded shoulders or a twenty-four (24) foot closed section road on a fifty (50) foot right-of-way. Note: In communities with stub roads or those having the likelihood of future expansion beyond 400 ADT, the road shall be constructed to residential sub-collector standards.

Where lots are between 10,000 square feet and 30,000 square feet, residential access streets shall be designed as a twenty-four (24) foot closed section road with mountable curb and five (5) foot wide sidewalks on both sides of the street on a fifty (50) foot right-of-way.

Residential access streets shall be designed as a thirty (30) foot closed section road with mountable curbs and five (5) foot wide sidewalks on both sides of the street on a fifty (50) foot right-of-way for communities with lots less than or equal to 10,000 square feet.

4) Town House Access

Town House Access roads shall provide direct access to individual town house units. The road shall be designed as a twenty-four (24) foot closed section road on a twenty-eight (28) foot right-of-way. Five (5) foot wide sidewalks (six (6) feet when adjacent to perpendicular parking locations) shall be provided along both sides of the road and shall be continuous. They shall connect to existing walks to extend to the nearest intersection of a higher classified roadway in order to create a complete pedestrian network and, if applicable, shall connect to existing or proposed adjoining communities. Pedestrian crossing locations shall be placed at a maximum spacing of five hundred (500) feet. Town house access roads expecting school bus traffic shall be thirty (30) feet wide on a thirty-four (34) foot right-of-way. Note that engineers shall take into consideration the removal of snow from the public town house roads and provide sufficient off-street locations for the snow to be deposited away from homes or parking areas.

No town house access road will be permitted to have average daily traffic volumes in excess of 450, which is approximately equal to seventy-five (75) townhouses (75 units x 6 trips/unit = 450), passing any single point of the roadway - a loop road may increase to 150 townhouses provided the center point of the roadway yields roughly equivalent traffic volumes on each side of the loop. Roads anticipated to exceed this limit shall be designed with a town house collector road; the design of which shall be a thirty (30) foot closed section road with a five (5) foot sidewalk on at least one side. The town house collector road shall function in a manner similar to the residential collector road in that no individual town house driveways or perpendicular parking pads will be permitted direct access to it.

III. ROADWAY/TRAFFICWAY DESIGN

A. Preliminary Considerations

The design of roadways includes general layout, alignment, grades, grading, paving widths, paving material, and location of drainage facilities. When determining alignments and grades of roadways, the designer must consider the requirements for design speed and required sight distance, utilities, storm drainage, and consider aspects of the design such as railroad crossings, trees, houses, driveways, etc. Roads classified as residential collector or lower have the additional function of being an integral part of a residential community. As such, their geometric designs shall include features that strongly discourage speeding; including curvilinear road design and institution of a road system that eliminates long, continuous road segments. All reasonable efforts to create an environment of slower vehicle speeds will be considered. In cases where the extent of the proposed design features are under contention, the Director shall have the final authority on the required improvements.

Wherever a preliminary drainage study indicates that the minimum right-of-way width as established in this Manual and in the Standard Details is inadequate for the drainage of a particular road, additional right-of-way shall be provided as directed by the Department of Public Works. The requirement must be made prior to the approval and recording of a dedication plat among the Land Records of Harford County.

B. Determination of the Typical Section

The typical section shall be determined by the Harford County Department of Public Works based upon roadway classification. Roadway classification shall be based on the Department of Planning and Zoning's "Transportation Plan - An Element of the Harford County Master Plan". Local road classification shall be based on ADT., lot size, land uses and number of units. The ADT shall be determined as specified in the Institute of Transportation Engineers Trip Generation Manual; current edition.

C. Modification of Typical Section or Design Criteria

To promote design variety in neighborhoods by allowing variability in width, section, alignment, and the use of traffic calming measures to meet specific design issues, the Director of Public Works may authorize alternative sections or modification to design criteria. Flexible design may be considered throughout the County, in limited situations, in accordance with the following:

1. Within the rural area, variability in section or design may be permitted in agricultural areas and within the rural villages for residential and business proposals and in land zoned at an appropriate density to enhance the character of the village.
2. Within the development envelope, variability in section or design may be permitted in areas of urban residential growth.

These modifications may be appropriate for alignments that preserve existing natural buffers for width and section adjustments that complement rural character, to improve neighborhood interconnectivity, reduce total street length and impervious cover, maximize the number of homes per unit length, or for the use of traffic calming measures to increase pedestrian activity through reduced speed. The goal is to provide, in limited situations at the discretion of the Director of Public Works, alternatives to the regulations of the Road Code if the plan meets the following objectives:

- a. The proposed street layout provides a circulation network for reduced traffic congestion.
- b. Road sections and streetscapes are designed to reduce traffic speeds, reduce visual impact of parking areas, and promote pedestrian safety.
- c. Vehicular and pedestrian connections are provided to existing, or proposed, community retail, civic and recreation facilities.

Applicants interested in submitting a subdivision for review under Flexible Design shall first schedule a pre-application meeting with the Department of Public Work's Development Coordinator, and other appropriate members of the Department of Public Works, to discuss how the innovative subdivision design demonstrates safety in achieving the goal and objectives of Flexible Design.

D. Intersection Criteria

1. Intersections of County Roads

Centerlines of roadways and of business/commercial/industrial use driveways shall continue through intersections without offsets, intersecting as nearly as possible at right angles. Where various conditions make a right angle intersection impractical, the deflection angle between the centerline of a proposed residential access street or a minor town house road and the centerline of any other street shall not be less than seventy (70) degrees. The minimum deflection angle between any other streets shall be eighty (80) degrees.

In consideration that four-leg intersections have thirty-two (32) conflict points (of which sixteen (16) are crossing type where one vehicle could impact the side of another) and three-leg, "T" intersections have only nine (9) conflict points (of which three (3) are crossing type movements); three-leg intersections shall be considered and pursued in all intersections where the priority roadway is classified as residential collector or higher. Studies have shown that "T" intersections average about half as many accidents per year as four leg intersections. If the alignment of two minor streets, at a residential collector (or higher classified) priority road, must occur at the same station of the priority roadway, a roundabout, traffic signal, or other traffic safety / capacity improvement (i.e. channelized right turn lanes), shall be considered, and may be required by the Director. Intersections between residential roads shall be no less than one hundred twenty-five feet (125) apart between roadway centerlines. Intersections between county residential roads and private roads shall be no less than one hundred twenty-five (125) feet apart

between roadway centerlines. County roadways shall not intersect a collector road or a business/industrial road at intervals less than four hundred feet (400') between centerlines. However, in light of the aforementioned safety aspects of "T" intersections, offset "T" intersections with closer spacing will be considered if their inbound left turn lanes do not stack in the same road area.

2. Intersections with State Roads

The intersection of County Roads with State Roads is subject to final approval by the Maryland State Highway Administration.

3. Residential/Commercial/Industrial Entrances (Driveways)

The Department of Public Works shall approve the number, configuration, and location of entrances that may be permitted; based on usage, interior and exterior traffic patterns and the proximity of the proposed entrance to existing or future roadway intersections.

At a minimum, the centerline of any new entrance shall be located from the nearest edge of paving of an intersecting street as follows:

Residential entrance	60 feet
Commercial entrance	60 feet
Industrial entrance	125 feet

Note: The residential entrance may be reduced to forty-five (45) feet on streets classified as residential access. Based upon the volume and classification of the adjoining road and the volumes generated by the commercial site, the sixty (60) foot length for residential and commercial sites may be increased by the Director.

Sufficient sight distance is required to enable proper and safe maneuvers on the part of the drivers turning into and out of the entrance. Intersection sight distance is required for all commercial and industrial accesses in accordance with AASHTO and the road's design speed. Unless otherwise required by the Department, accesses within commercial/industrial subdivisions are considered to have acceptable sight distances and may forego the required sight distance analysis. All other commercial/industrial accesses shall perform a sight distance analysis as stipulated in Section III.E.2.b.

Residential driveways are likewise required to meet intersection sight distance requirements. However, if the intersection sight distance is not obtainable for a particular residential driveway without significant capital investment, the Department may permit the access, under the pretense that every reasonable effort was made to increase the sight distance. When this occurs, the required sight distance will be as stipulated by this Department based upon traffic volumes, road classification, design speed, number of residential units, etc. Unless otherwise approved by the Director, an access will not be permitted if the stopping sight distance for the priority road's design speed is not obtainable. The need for a sight distance analysis in conformance with

Section III.E.2.b for residential driveways will be determined on a case-by-case basis by the Utility and Access Permit personnel in the Department.

4. Auxiliary Lanes

The installation of auxiliary lanes shall be a site specific requirement, dependent upon the existing and projected road volumes and available sight distance. Auxiliary lanes increase the capacity and safety of the roadway by removing the turning vehicles from the through lanes of traffic. For analysis purposes, "future" traffic shall be calculated in accordance with the standards set forth in the Department of Planning and Zoning's Adequate Public Facilities Ordinance.

a. Deceleration Lanes

Deceleration lanes shall be installed when the percentage of right turning vehicles relative to the directional flow of traffic exceeds ten (10) percent and the volume of right turns is at least ten (10) in the peak hour. When the peak hour volume of right turns exceeds fifty (50), a right turn lane shall be required, regardless of the percentages. Deceleration lanes shall be designed as follows with the designated entering truck volumes being those that are turning right into the site and would, thereby, use the deceleration lane.

DECELERATION LANE DESIGN			
Posted Speed Limit	Deceleration Length	Taper Length	Width
Residential Applications (and Commercial Site Accesses with limited truck traffic) (i.e. 5 or fewer entering trucks per day)			
30	175'	100'	10'
35	225'	120'	10'
40	275'	120'	10'
Commercial and Industrial Applications (with Significant Truck Traffic) (i.e. more than 5 entering trucks per day)			
30	250'	120'	12'
35	325'	150'	12'
40	400'	150'	12'

Unless specifically requested for safety and/or capacity concerns by the Department of Public Works, deceleration lanes will not be required for internal subdivision roads and roads with posted speed limits below 30 MPH.

b. Left-Turn Lanes

Left-Turn lanes shall be installed when any combination of advancing volumes, opposing volumes and percentages of left turning vehicles exceed the limits identified in the appropriate chart. These lanes shall be installed in accordance with the appropriate chart in Appendix 1.

c. Acceleration Lanes

Acceleration lanes, when deemed necessary by the Department of Public Works shall be installed in accordance with current AASHTO standards.

E. Sight Distance

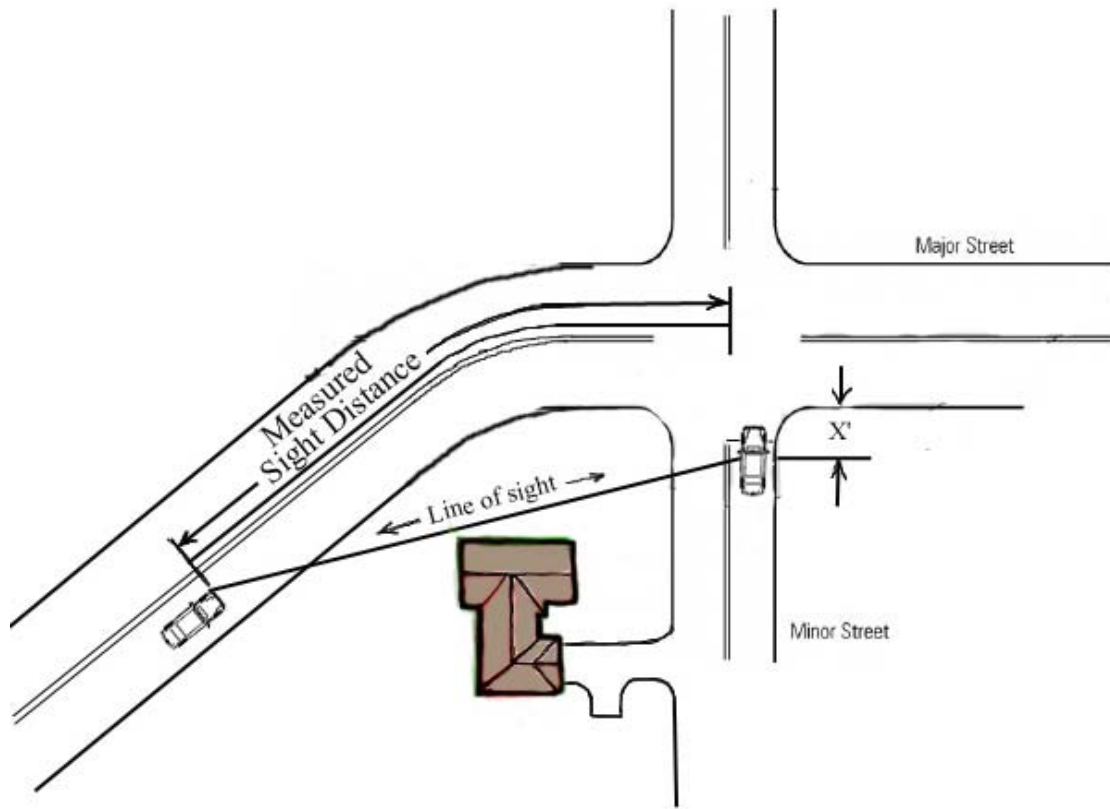
1. Stopping Sight Distance

Stopping Sight Distance shall conform to requirements established in this design manual and in AASHTO. (Refer to chart in Appendix VII for the most recent distance requirements as stipulated by AASHTO at the time of release of this document.)

Newer versions of this manual or AASHTO shall supersede those distances when applicable.

2. Intersection Sight Distance

Intersection Sight Distance shall conform to requirements established in this design manual and in AASHTO. Note that the measured sight distance is calculated along the centerline of the road, wherein the line of sight is the direct view of the approaching vehicle (see description below).



The intersection setback from the priority road's flowline ("X" in the above sketch) is as specified in the current edition of AASHTO.

a. New Intersections within a Subdivision

For new intersections within a subdivision, the required intersection sight distance, line of sight view shall be shown on the plan view of the engineering drawings for all intersections. If the required line of sight remains within the County's right-of-way, the sight distance may be shown on the standard centerline profile for the priority road and no additional documentation will be necessary. In the event that the line of sight is outside of the County's right-of-way, the engineer shall identify it on a separate profile that follows the topography of the line of sight. Additionally, the engineer shall provide an intersection sight distance easement across the private property that will restrict the installation of any vegetation or structure that is higher than twenty-four (24) inches. (This height restriction may need to be modified higher or lower dependent upon the grade of the approach.)

b. New Intersections with Existing County Roads

For new intersections with an existing County road outside of a subdivision, an intersection sight distance analysis shall be provided and approved in accordance with the criteria established in this manual prior to the release of the preliminary plan approval. For a location obviously demonstrating little or no obstructions, the County's Geographic Information Systems (GIS) topography may be used to identify the available sight distance along the line of sight. However, in the event that there exists a potential obstruction along the line of sight (i.e. an over-vertical,

an embankment, vegetation, structures, etc), a topographical survey shall be completed to demonstrate that the sight distance requirements are being met. If necessary, additional right-of-way and/or easements shall be provided to ensure that the line of sight is not compromised in the future.

F. Cul-de-sacs/ Temporary Tee Turn-Arounds

1. Cul-de-sacs

Permanent dead-end streets with a circular turn-around at the closed end shall be provided in accordance with Department of Planning and Zoning regulations and/or as required by the Department of Public Works. The radius of the paved circular portion shall be a minimum forty (40) feet with a right-of-way radius of fifty (50) feet. When requested by the Harford County Board of Education to provide for a school bus turn-around, the minimum radius of the paved circular portion of the cul-de-sac shall be fifty-five (55) feet with a right-of-way radius of sixty-five (65) feet. A landscaped central island shall be provided for school bus cul-de-sacs in residential subdivisions.

For industrial parks, the minimum cul-de-sac radius shall be fifty-five (55) feet and the minimum right-of-way radius shall be sixty-five (65) feet.

In town house developments, perpendicular parking pads and driveways are permitted around the perimeter of the cul-de-sac, but shall not be located within five (5) feet of any inlet or the return points of the reverse curve.

If the designer considers a circular turn-around to be inadequate in town house or single family communities, a special rectangular cul-de-sac may be used (see Standard Details). The rectangular cul-de-sac shall be limited in size so as not to replace a proper roadway network (see limitations on the Standard Details). When used as a school bus turnaround, the designer shall provide documentation (i.e. a turning movement analysis) that indicates the school bus can easily navigate around the island.

Cul-de-sac geometry shall be as shown on the Standard Details.

Curb and gutter shall be constructed around the perimeter of all cul-de-sacs and around all interior islands. If desired, the curbing may include periodic openings to provide for stormwater runoff into open swales.

When islands are planned in cul-de-sacs, a landscaping plan shall be approved by the Department of Public Works. The long term maintenance of the area shall be the responsibility of the Developer and the Homeowners Association (HOA) and shall be stipulated as such in the HOA Covenants and Restrictions recorded in the Department of Planning and Zoning with the Record Plat for the subdivision.

2. Temporary Tee Turn-Arounds

If a street designed as a temporary dead end street is to be extended into a through street at a future date, a temporary tee turn-around shall be used in place of a cul-de-sac.

The width of the turn-around shall equal the width of the right-of-way. Where the distance between the property line and the edge of the pavement permits, a turn radius of ten (10) feet shall be used (see Tee Turn-Around, Standard Details).

No access shall be permitted along any portion of a temporary tee turn-around.

A tee turn-around shall not be required if the stub road is fronted by no more than one (1) lot per side and does not exceed one hundred (100) feet in length.

The grading of the right-of-way shall be extended beyond the tee turn-around to allow for the extension of the roadway with minimum impact upon the lots along the area of the tee turn-around. Reversible slope easements shall be provided on the lots adjacent to the tee. The designer shall provide information for future slope grading to justify the limits of this easement to the satisfaction of the Department of Public Works.

G. Road End Signing

Any roadway ending in a tee configuration shall be signed with two (2) red diamond delineators and a six (6) inch by thirty (30) inch "Future Road" sign; in accordance with the Standard Detail.

Should the grade beyond the end of the "T" or adjacent to the "T" within fifty (50) feet exceed a four to one (4:1) slope, strong post w-beam guard rail shall be installed in conjunction with the aforementioned signage.

H. Maintenance of Traffic Plan

Maintenance of traffic plan shall be in accordance with the latest edition of the Federal Highway Administration's Manual on Uniform Traffic Control Devices (M.U.T.C.D.) and all State Highway Administration Specifications and Supplements.

Unless otherwise approved by the Department of Public Works, no single lane closures will be allowed during peak travel times, which are Monday through Friday from 7:00 a.m. to 9:00 a.m. and from 4:00 p.m. to 6:00 p.m. on roads classified as collector or higher by the Department of Planning and Zoning.

I. Alleys

Alleys shall be designed as private roads with a minimum width of twenty (20) feet. The radius of curb returns shall be fifteen (15) feet when intersecting with existing County residential roads.

J. Bus Stops

If a public transportation route is in operation or planned to be in operation, a stopping lane ten (10) feet wide by thirty (30) feet long with a seventy (70) foot transition to the existing pavement edge shall be provided where specified by the Department of Planning and Zoning.

Sufficient right-of-way shall be set aside in the vicinity of the stopping lanes so at the completion of construction, the right-of-way line shall be at least twelve (12) feet beyond the edge of pavement.

IV. GEOMETRIC DESIGN

A. County Roads Excluding Town house Roads

1. Horizontal Alignment

a. Horizontal Curves

1) Design Speed Minimum Radii

When selecting the alignment for a given roadway classification, the design speed and minimum radii of horizontal curves shall be limited as shown in Appendix 1 on Table 1 of this manual. This manual establishes the minimum design requirements and the designer is encouraged to use professional skill, experience and judgment to develop the most feasible and practical design for the planned facility.

2) Curve Data -

Horizontal curve data shall be computed by the arc definition of a circular curve.

3) Minimum Curve Length

The minimum length of a horizontal curve shall be one hundred (100) feet.

4) Reverse Curves

A tangent length of one hundred (100) feet minimum shall be used between reverse curves; residential access streets and town house roads excluded.

5) Compound Curves

Compound curves may be used when horizontal curves are super-elevated and the compound curves are used to transition into and out of the super-elevation section. The radius of the flatter curve shall not be more than one and one-half (1.5) times greater than the radius of the sharper curve.

6) Curve Widening

Horizontal curves with radii of five hundred (500) feet or less need to be widened on the inside edge of access and sub-collector roads when the pavement width is less than thirty-six (36) feet and the lot size is less than three quarter (3/4) acre. The adjacent property line shall be cut back to maintain the standard edge of pavement to property line width.

Widening shall be accomplished at the midpoint on the curve and shall conform with the method shown on the appropriate chart.

b. Driveways/Panhandles

Driveways and panhandles should be located such that they result in no undue interference or hazard to the free movement of normal traffic and no areas of traffic congestion are created on the roadway. In accordance with these principles, driveways and panhandles should be located where the roadway alignment and profile are favorable; i.e., where there are no sharp curves or no steep grades, where they meet or exceed the sight distance for the priority roadway. Driveways or panhandles should be avoided at locations that would interfere with the placement and proper function of highway signs, signals, lighting or other devices affecting traffic operation.

Existing driveway entrances shall be shown on the plan, identified by station and shall be shown in profile or cross sections to ensure acceptable approach grades are maintained.

Driveway entrances shall not be permitted within five (5) feet of the closest edge of any inlet.

Proposed driveway entrances and panhandle layout shall conform with the applicable Standard Typical Driveway Entrance Detail.

Driveways and panhandles that intersect existing County roads shall conform with Section III.E.2.b of this manual for sight distance requirements unless otherwise specified. Panhandles in excess of one hundred (100) feet in length shall not be permitted to access open-section County roads at the top of a "T" intersection. A minimum offset of fifty (50) feet from the Point of Intersection (P.I.) of the "T" to the panhandle driveway shall be provided.

A driveway access permit is required for each lot. See Appendix 5 for additional requirements and stipulations on access permits.

c. Commercial and Industrial Entrances

Commercial and industrial entrances shall be designed to accommodate the type and volume of site generated traffic; the direction of the predominate traffic movements, and the volume of the main street traffic (i.e., sites generating a significant number of tractor trailers shall have greater turning radii and wider entry widths, whereas for low volume site generators that egress into low volume, low speed streets, the entrance may suffice with a narrow entry width and smaller turning radii).

To reduce the number of conflict points along a road segment, developers should pursue inter-parcel connections and/or shared entrances for adjacent commercial parcels.

The following standards are provided as an initial guideline. However, the Department of Public Works reserves the right to modify them, as deemed appropriate, according to the aforementioned criteria. As such, the engineer may request deviations from these guidelines. However, the request shall be submitted with an explanation as to why these guidelines are not

appropriate for the given situation (i.e. very low traffic volumes, directional flow of the majority of traffic, very limited truck use, etc.).

	Entry Width	Curb Radius
Commercial	25'	35'
Commercial	30'	30'
Commercial	35'	25'
Industrial	35'	35'

d. Intersection Geometry

The radii of curbs and pavement edges at intersections shall be governed by the following criteria:

At an intersection of any residential road within the confines of a subdivision (not including the main access), the radius of the returns shall be twenty (20) feet to face of curb or thirty (30) feet to edge of pavement where no curbs exist. Any residential road intersecting with a road classified as a collector or higher shall have a radius of thirty (30) feet.

At an intersection of any roads within a commercial area the radius of the returns shall be twenty-five (25) feet and within an industrial area, the radii shall be thirty-five (35) feet.

At all other intersections, the radius of return shall be twenty-five (25) feet for closed section roads and thirty (30) feet for open section roads.

When a curbed trafficway intersects a non-curbed trafficway, the radii of the returns shall be as indicated above. The curb shall be extended for the full length of the acceleration/deceleration lane and be nosed down on an open section road. Where no acceleration/deceleration lane is present the curb shall extend along the full length of the arc of the curb return and nosed down.

At an intersection of an alley and a street, the standard radius of the return shall be fifteen (15) feet to face of curb. Where the distance on the street between the face of curb and property line is less than twenty (20) feet, that distance shall become the return radius.

The truncation of property lines at intersections shall be governed by the following criteria:

At an intersection of roadways, including alleys, the minimum truncation of the property line shall be a chord connecting the points on the property lines directly opposite the Point of Curve (P.C.) and Point of Tangent (P.T.) of the curb return or edge of pavement return.

e. Special Design Elements

Should the designer decide to incorporate or should the Department of Public Works require incorporation of any of the following elements in the roadway design, the following standards shall be met:

1) Roundabouts

A roundabout is an intersection with a central island in which traffic circulates in a counter-clockwise direction, where entering traffic must yield to circulating vehicles. The roundabout can routinely handle a greater volume of traffic and operate more safely than a "normal" controlled intersection. Roundabout design shall be in accordance with the Maryland State Highway Roundabout Design Manual; and/or the Federal Highway Administration's Roundabout Design Guidelines; both shall utilize the latest edition. Typical geometric design features for roundabouts on Harford County roadways include a one hundred ten (110) foot to one hundred twenty (120) foot diameter, a thirteen (13) foot entering lane width, a fifteen (15) foot circulating roadway width, a fifteen (15) foot exit lane width, a truck apron, raised splitter islands and a raised center island. The diameter of lower volume roundabouts (typically found within a residential subdivision) may be modified, provided the other geometric design criteria are met, adequate deflection is provided on the entrance to the roundabout, and a WB-50 design vehicle can negotiate the roundabout without encroaching on the curbs

For roundabouts within the confines of a subdivision, a landscaping plan for the central island and splitter islands (if applicable) shall be approved by the Department of Public Works. The long term maintenance of the area shall be the responsibility of the Developer and the Homeowners Association (HOA) and shall be stipulated as such in the HOA Covenants and Restrictions recorded in the Department of Planning and Zoning with the Record Plat for the subdivision.

Roundabouts may be considered at the intersection of any roadways and may be required by the Department of Public Works at any roadway classified as Collector or higher. They shall be subject to the approval of the Department of Public Works.

2) Monumental Entrances

Monumental entrances are divided roadways generally placed at the main entrance to a community. The median shall include a seven (7) inch vertical curb and the width shall be at least eight (8) feet (fifteen (15) feet if trees are included in the landscaping plan) and the pavement widths shall be set at a minimum of eighteen (18) feet on the inbound lane and twenty-four (24) feet on the outbound side. The radius of the returns and the offset of the median shall be as shown in Appendix 1. The designer shall demonstrate the ability of a WB-50 design vehicle to enter and exit the road from both directions without encroaching upon the curbs. If necessary, the pavement widths shall be increased and/or the nose of the median set back, to accommodate those movements. The length of the aforementioned section shall be a minimum of one hundred (100) feet long, then transition on the outbound side of the road at a fifteen to one (15:1) minimum ratio to the standard road width. If the traffic impact analysis determines that a longer storage area is required, the length of the median shall be sized accordingly.

The road right-of-way shall be appropriately increased to accommodate the additional paving and shall be subject to the approval of the Department of Public Works.

3) Divided Roadways

Divided roadways may be constructed for residential or commercial developments and designed in accordance with the following criteria.

a) Residential Divided Roadways

] Residential divided roadways are sections of road separated by a median, with a minimum width of fourteen (14) feet. There is no maximum median width; however, at intersections, the width shall not exceed fourteen (14) feet in order to minimize the amount of paving and confusion. In light of the flexible design standards previously mentioned in this manual, the median width may be increased to fifty (50) feet at intersections if the priority road is treated as two one-way roads and the intersections are treated as completely separate entities.

This roadway section is designed to be aesthetically pleasing and, as such, may have a planted median. The plantings shall not reduce intersection sight distance, and shall be located outside of the identified "clear zone". A landscaping plan shall be approved by the Department of Public Works. The long term maintenance of the area shall be the responsibility of the Developer and the Homeowners Association (HOA) and shall be stipulated as such in the HOA Covenants and Restrictions recorded in the Department of Planning and Zoning with the Record Plat for the subdivision.

Residential divided roadways shall be designed with no or limited residential accesses and no on-street parking.

Residential divided roadways shall be constructed as fourteen (14) foot lanes with seven (7) foot graded shoulders when the outside edge is an open section roadway. When the outside edge of the road is closed, the width shall be increased to fifteen (15) feet. The median shall be constructed with seven (7) inch vertical curb and gutter.

Sidewalks on at least one side of the road outside of the ditch line (or if a closed section roadway, one (1) foot off of the right-of-way line) shall be included. To enhance the scenic qualities of the road sections, a meandering sidewalk is preferred.

At intersections, the median shall be offset sufficiently from the Point of Intersection (P.I.) to routinely accommodate all emergency vehicles, school buses and commercial single unit trucks without encroaching onto the curbing. The nose of the island shall be turned down as shown in Plate S-6 to allow larger vehicles to more easily traverse the turns.

Curbing, grading, drainage and right-of-way width shall be subject to the approval of the Department of Public Works.

b) Commercial Divided Roadways

Due to concerns regarding turning movements with frequent truck traffic, commercial divided roadways will not be permitted on County roads in Industrial or Commercial areas, unless specifically approved by the Director or an alternate suitable truck access is provided with the divided road being used exclusively for passenger vehicles.

2. Vertical Alignment

a. Grades

1) Minimum Grade

The minimum allowable tangent grade of proposed closed section roadways shall be eight tenths (0.8) percent. Open section roadways have no minimum grade criteria. Roadway sumps shall be adjusted to provide a minimum of one half (0.5) percent grade to the sump location.

2) Maximum Grade

The maximum grade, based upon roadway classification, shall be as shown on the table in Appendix 1.

3) Profile Grade Line

Roadway profile grade line location shall be identified on the Typical Road Section. The profile shall normally be defined as the centerline of the road or the location of the normal crown.

b. Intersection Criteria

1) Intersection with County Roads

At an intersection of two roadways, the normal typical section of the priority roadway shall continue through the intersection without break. Where roadways of equal importance intersect, one shall be considered as a priority roadway in order to accomplish the foregoing connection. The Department of Public Works shall determine the priority traffic way for roads of equal status.

When the grade of a residential collector or higher classified roadway (when functioning as the non-priority approach to an intersection) exceeds four (4) percent, that grade shall be broken at least fifty (50) feet in advance of the station at the flow line of the curb or the edge of the traveled way of the priority roadway. The non-priority roadway must remain in the tangent grade at four (4) percent or less for a minimum of fifty (50) feet.

When the grade of the non-priority roadway exceeds six (6) percent at an intersection, that grade shall be broken at least fifty (50) feet in advance of the station at the flow line of the

curb or the edge of the traveled way of the priority roadway. The non-priority roadway must remain in the tangent grade at six (6) percent or less for a minimum of fifty (50) feet.

When the grade of a residential access street or a town house road serving twenty-five (25) units or less exceeds eight (8) percent, that grade shall be broken and remain in the tangent grade of four (4) percent or less for at least twenty-five (25) feet in advance of the station at the flow line of the curb or the edge of the traveled way of the priority roadway.

To facilitate smooth curb roll outs at tee intersections, the tangent top curb grade of the side roadway shall be maintained into the low curb Point of Intersection (P.I.) of the through roadway when the non-priority roadway is on a descending grade into the intersection. When the non-priority roadway is on an ascending grade into the intersection, the tangent top curb grade of the non-priority roadway shall be maintained into the high curb Point of Intersection (P.I.) of the through roadway. The remaining curb shall be transitioned with a vertical spline curve to meet the remaining curb Point of Intersection (P.I.) of the through roadway. The minimum length of a curb transition shall be fifty (50) feet from the Point of Intersection (P.I.). The design engineer shall ensure adequate drainage.

2) Intersections with State Roads

Approach grades to Maryland State Highway Administration roadways shall be governed by the State Highway Administration criteria.

c. Vertical Curves

1) Use of a Vertical Curve

To avoid an abrupt change in vertical alignment when passing from one grade to another, a vertical curve shall be used at the grade intersection.

Elevations on vertical curves shall be computed by parabolic curve formulas.

2) Design

To design crest and sag vertical curves, the minimum length of curve must be established. This minimum length shall be the greater of the following: one hundred (100) feet, three (3) times the design speed, or a constant ('k') multiplied by the algebraic difference of the two tangent grades in percent. Per AASHTO:

Design Speed	Crest 'k'	Sag 'k'
25 mph	20	30
30 mph	30	40
35 mph	50	50
40 mph	80	70

(For other design speeds, refer to AASHTO.)

Vertical curves shall be labeled with a Stopping Sight Distance (SSD) for crest curves and a Headlight Sight Distance (HSD) for sag curves; along with other pertinent data.

3) General Controls

- a) Short tangents between horizontal and vertical curves should be avoided.
- b) An effort shall be made to avoid the placing of sharp horizontal curves along pronounced over-vertical curves. Where such design is unavoidable, the limits of the horizontal curve shall extend beyond the limits of the vertical curve.
- c) An effort shall be made to avoid placement of sharp horizontal curves at or near the low point of a pronounced sag vertical curve. Where such design is unavoidable, the limits of the horizontal curve shall extend beyond the limits of the vertical curve.
- d) Horizontal curvature should be made as flat as possible at intersections.

d. Linear Profiles

1) Minimum Grade

The minimum grade along the linear profile shall be eight tenths (0.8) percent.

2) Minimum Curve Length

The minimum vertical curve length shall be fifty (50) feet.

e. Super-Elevation and Transitioning

Horizontal curves of closed section; interstate, parkway, arterial, and collector roadways, shall normally be super-elevated, or warped except as directed by the Department of Public Works.

The maximum rate of super-elevation for a closed section roadway shall be four (4) percent. The maximum rate of super-elevation for an open section roadway shall be six (6) percent. All other roadways except residential roadways shall be super-elevated in accordance with AASHTO criteria.

Transitions to and from this super-elevation shall be designed in accordance with AASHTO criteria.

Along horizontal curves, the outside top curb grade or grade along the outside edge of pavement shall not be less than one-half (0.5) percent; therefore, centerline grades must exceed one-half (0.5) percent in order that the warping can be accomplished without decreasing the grade along the outside edge of the roadway below one-half (0.5) percent.

To super-elevate, pavements shall be rotated around the centerline, except where such procedure would adversely affect adequate drainage design. To avoid such a situation the design engineer may rotate the super-elevation around the inside or outside edge of pavement, whichever affords the best drainage design.

Two-thirds (2/3) of the super-elevation runoff shall be accomplished on tangent, and the remaining one-third (1/3) shall be accomplished on the curve. A minimum super-elevation run out length shall be fifty (50) feet.

B. Town House Roads

The typical section for town house roads shall be constructed according to the Standard Details.

1. Horizontal Alignment

The minimum centerline radius for the horizontal layout of a town house road may be fifty (50) feet when the centerline deflection angle is sixty (60) degrees or greater.

For intersections with centerline radii less than or equal to one hundred (100) feet, the outside curb radius may be constructed as non-concentric. Under this condition, the minimum outside radius shall not be less than the centerline radius minus fifteen (15) feet.

The inside curb radius shall be concentric with the centerline radius.

2. Vertical Alignment

The maximum roadway grade shall be ten (10) percent. In road segments that include perpendicular parking, the maximum roadway grade shall be six (6) percent.

3. Cross Slope

The cross slope for the roadway shall be three-eighths inch per foot (3/8":1') or three (3) percent. The cross slope for areas of perpendicular parking shall be one-quarter inch per foot (1/4":1'), rising from the flow line.

In the case of a rectangular cul-de-sac where perpendicular parking occurs on one side of the road, a constant cross slope of three-eighths inches per foot (3/8":1') or three (3) percent may be used provided that the road slopes downward to the side along which there is parking.

4. Perpendicular Parking

Perpendicular parking pads shall not be allowed within twenty-five (25) feet of the point of intersection of the centerlines of two (2) town house roads across the area at the top of a "T" intersection and within fifty (50) feet of the Point of Intersection (P.I.) on all other approaches.

When town house roads intersect roads classified as residential collector or higher, no perpendicular parking will be permitted within fifty (50) feet of the flowline of the priority road.

When the centerline radius of the roadway is less than one hundred (100) feet, no perpendicular parking pads or driveways shall be permitted along the inside of the curve and on the tangent within fifteen (15) feet of the Point of Curve (P.C.). and Point of Tangent (P.T.). of the curve. To delineate this area, "No Parking" signs shall be installed in accordance with the M.U.T.C.D.

V. TREES WITHIN THE COUNTY RIGHT-OF-WAY

A. General

Street trees are a valuable asset to the development of a community and roadway network. They shade pedestrian walkways; act as evaporative coolers and their aesthetics contribute to community livability. They also act as air purifiers trapping large quantities of dust and particulate matter, consume carbon dioxide and release oxygen and contribute to the control of storm runoff by intercepting rain water. By working to conserve existing forested areas, and planting new areas within trees and forests as part of the site design and construction process, the effect of change to the visual as well as environmental landscape is minimized.

For street trees or group of trees to be retained as part of the site planning/construction process, every effort should be made to select a roadway alignment and utilize construction protection techniques that preserve specimen trees and high priority forested areas as defined within the provision of the Harford County Forest Conservation Law (§267-30) and the guidelines of the companion Forest Cover Conservation and Replacement Manual. Both of these documents are available from the Harford County Department of Planning and Zoning. The designer is also strongly encouraged to consult the Forest Cover Conservation and Replacement Manual, a tree specialist, and/or standard arbor culture texts for proper methods of tree preservation along roadway cuts or fills.

For street trees or groups of trees to be planted within the right-of-way, species are to be selected from the species prescribed within paragraph (D), the Tree Selection provisions, of this Section. In general, species should be varied for texture, color and form and selected to be compatible with the scale of the roadway, intersections, adjacent improvements, and any underground, or overhead, utilities. This Section discusses provisions for situations where trees will be retained (B. Existing Trees and Forests) adjacent to a roadway, and where trees are to be planted (C. Planted Trees and Forests) adjacent to a roadway. For the purpose of this Section the term ‘street tree’ shall refer to a single width, linear planting or retention of trees which parallels the direction of a road. “Grouped trees” or plantings will refer to the retention or planting of more than one tree to provide a landscaped effect, a buffer, or to preserve an important stand of trees for environmental benefit, use as a buffer, or historic preservation reasons.

B. Existing Trees and Forests

1. General

The Maryland Department of Natural Resources, under the Roadside Tree Law (§5-401), regulates the pruning or removal of a tree within any public right-of-way (state, county, town, city). Additionally, the Harford County Forest Conservation Law and Forest Cover Conservation and Replacement Manual regulate tree and forest resources during the site planning and construction process. These documents, and the requirements of this Section, should be consulted as it is likely that their provisions will influence road design and any impacts to existing forested areas to be retained within the County right-of-way.

2. Location

- a. For closed section roads where no sidewalk is proposed, existing trees or forested areas are permitted six (6) feet from the back of the curb.
- b. For closed section roads where a sidewalk is proposed, existing trees or forested areas are permitted six (6) feet from the edge of the sidewalk away from the road.
- c. For open section roads where no sidewalk is proposed, existing trees or forested areas are permitted six (6) feet from the edge of the drainage swale away from the road.
- d. For open section roads where a sidewalk is proposed, existing trees or forested areas are permitted six (6) feet from the edge of the sidewalk away from the road.

C. Planted Trees and Forests

1. General

The Harford County Forest Cover Conservation and Replacement Manual permits the planting of street trees as a mitigation technique under the provisions of the Zoning Code (Article V.A.). The Forest Cover Conservation and Replacement Manual and the requirements of the Section should be used for the design of street tree plantings and group plantings within the County right-of-way.

2. Location

Planted trees shall be installed at the distances specified below to maintain safety and prevent interference with utility structures within the right-of-way. Street trees shall not obstruct or obscure any traffic control signs or sight distance.

Locate trees a minimum distance of:

- a. 85 feet from the approach to any stop sign
- b. 50 feet from the approach to a traffic or directional sign
- c. 25 feet from a light or utility pole
- d. 10 feet from an entrance drive or alley
- e. 5 feet from a drain, drain inlet structure

- f. 5 feet from an open space access strip or easement
- g. 5 feet from any underground utility
- h. 150 feet from the sight line of a stop controlled intersection. (Locations within this limit may be considered when the geometrics / curvature of the road is such that sight distance is improved. Waivers for this item must provide a line of sight analysis prior to receiving approval.)

3. Street Trees and Grouped Plantings

- a. When the distance between the back of the curb and sidewalk is six (6) feet or greater, street trees shall be located within the right-of-way and shall be centered between the curb and the sidewalk. Grouped plantings shall not be permitted between the curb and sidewalk.
- b. When the distance between the back of the curb and the sidewalk is less than six (6) feet, and where street trees or groupings of trees are planted closer than three (3) feet to the sidewalk, a biologic root inhibitor barrier or physical container barrier shall be required.
- c. When the distance between the curb and the sidewalk is less than six (6) feet, street trees or group plantings may be installed three (3) feet from the sidewalk in the direction away from the road. A tree maintenance easement shall be required if there is less than five (5) feet from the tree(s) to the right-of-way limit. For street trees the easements shall be ten (10) feet. For grouped plantings the easement will be determined on a site by site basis.
- d. Trees shall be planted a minimum of six (6) feet behind the curb or edge of graded/paved shoulder (open section roads) when there are no sidewalks. Trees shall not be planted within the limits of the defined drainage swales (open section roads).

D. Tree Selection

When selecting trees for a particular location, the following must be addressed:

- 1. Trees must fit the space limitations when matured. The species, ultimate size of the tree and the canopy desired should be compatible with the size of the right-of-way and the road classification (i.e., local, collector or arterial road).
- 2. Trees must survive the environmental stresses of the proposed location. The selection included herein have been generally considered for branching habits, local soil and rainfall, native pests, salt tolerance, and disease.

3. Trees planted within the County right-of-way shall be selected from the Forest Cover Conservation and Replacement Manual, or the recommended tree list found herein in Section E. (Note: Evergreen trees are not permitted within the Harford County right-of-way.)
4. Trees with a canopy spread of fifteen (15) to thirty (30) feet shall be planted a minimum of thirty (30) feet apart and trees with a canopy spread of thirty (30) feet and up shall be planted a minimum of forty (40) feet apart. The minimum size for all trees within the right-of-way shall be one and one-half (1 1/2) inch caliper.
5. Trees with a canopy spread of thirty-five (35) feet and up are preferred as street trees. Trees with a canopy spread of ten (10) to thirty (30) feet are desirable as they provide variety in the roadscape. Trees are not permitted in situations where they inhibit sight distance, conflict with pedestrian circulation or result in maintenance problems. Trees with a canopy spread of ten (10) to thirty (30) feet will be permitted under the following conditions and in the following locations:
 - a. Within rights-of-way when:
 - 1) no sidewalk is required,
 - 2) the distance between the curb and the sidewalk is six (6) feet or greater,
 - 3) the tree may be pruned to eight (8) foot clear trunk without destroying the shape of the crown of the tree, or
 - 4) under overhead utility lines
 - b. In tree easements adjacent to the right-of-way.
 - c. In median strips of divided highways, provided that trees are located a minimum of twenty (20) feet from the nose of the median island.
6. Every effort shall be made to diversify species and cultivars of species of trees planted on different roads, between blocks, and on roads or cul-de-sacs over eight hundred (800) feet in length. This practice provides for long term survival of the landscape, should one species suffer a disease or insect outbreak.
7. Trees planted under utility lines must be selected from the Forest Cover Conservation and Replacement Manual and must have a canopy spread of twenty (20) feet or less.

8. All material is to conform to the “American Association of Nurserymen Standards for Nursery Stock”, latest edition. Installation and general maintenance of planted stock shall be in accordance with the references listed in the Forest Cover Conservation and Replacement Manual.
9. No needle evergreen trees will be permitted in a public right-of-way. No thorn bearing trees or trees with rigid, sharply point leaves (such as holly trees) will be permitted adjacent to sidewalks.
10. Trees planted to satisfy reforestation requirements under the Harford County Forest and Tree Conservation Regulations, must be species native to Maryland or otherwise approved by the Department of Planning and Zoning.

E. Recommended Tree List

Small - Less than 30'		Minimum lawn strip - 3' wide
<u>COMMON NAME</u>	<u>SCIENTIFIC NAME</u>	<u>HEIGHT</u>
Hedge maple	<i>Acer campestre</i>	25'
Amur maple	<i>Acer ginnala</i>	20 - 25'
Paperback maple	<i>Acer griseum</i>	20 - 25'
Katsura-tree	<i>Cercidiphyllum japonicum</i>	20 - 30'
American redbud	<i>Cercis canadensis</i>	12 - 25'
Whiteflowering dogwood	<i>Cornus florida</i>	15 - 25'
Redflowering dogwood	<i>Cornus florida rubra</i>	15 - 20'
Kousa dogwood	<i>Cornus kousa</i>	16 - 18'
Cornelian cherry	<i>Cornus mas</i>	20 - 25'
Thornless Cockspur hawthorn	<i>Crataegus crusgalli inermis</i>	18 - 20'
Lavalle hawthorn	<i>Crataegus lavallei</i>	20 - 25'
Autumn Glory hawthorn	<i>Crataegus oxyacantha</i> “Autumn Glory”	18 - 22'
Washington hawthorn (tree form)	<i>Crataegus phaenopyrum</i>	12 - 15'
Goldenrain tree	<i>Koeleruteria paniculata</i>	25 - 30'
Siberian crabapple	<i>Malus baccata</i>	20 - 25'
Upright Siberian crabapple	<i>Malus baccata columnaris</i>	22 - 25'
Radiant crabapple	<i>Malus</i> “Radiant”	12 - 15'
Snowdrift crabapple	<i>Malus</i> “Snowdrift”	18 - 20'
Purpleleaf flowering plum	<i>Prunus cerasifera</i> “Thundercloud”	12-15'
Medium - 30-40'		Minimum lawn strip - 4' wide
Crimson King Norway Maple	<i>Acer platanoides</i> “Crimson King”	30 - 40'
Goldspire sugar maple	<i>Acer saccharum columnare</i> “Goldspire”	40 - 50'
Sentry sugar maple	<i>Acer saccharum monumentale</i>	40 - 50'
Pyramidal European hornbeam	<i>Carpinus betulus fastigiata</i>	30 - 50'
Kentucky coffeetree (male only)	<i>Gymnocladus dioica</i>	40 - 50'
American hophornbeam	<i>Ostrya virginiana</i>	40'
Sargent cherry	<i>Prunus sargentii</i>	30 - 40'
Whitehouse callery pear	<i>Pyrus calleryana</i> “Whitehouse”	30 - 40'
Capital callery pear	<i>Pyrus calleryana</i> “Capital”	30 - 40'
Chinese scholar tree (Pagoda tree)	<i>Sophora japonica</i>	30 - 40'

Regent scholartree	<i>Sophora japonica</i> "Regent"	30 - 40'
Columnar Norway maple	<i>Acer platanoides</i> <i>columnare</i>	50 - 75'
Emerald Queen Norway maple	<i>Acer platanoides</i> "Emerald Queen"	60 - 80'
Schwedler Norway maple	<i>Acer platanoides</i> "Schwelderi"	40 - 60'
Red Maple, October Glory	<i>Acer rubrum</i> "October Glory"	50 - 60'
Red Maple, Autumn Glory	<i>Acer rubrum</i> "Autumn Glory"	50 - 60'
Red Maple, Autumn Flame	<i>Acer rubrum</i> "Autumn Flame"	50 - 60'
Red Maple, Red Sunset	<i>Acer rubrum</i> "Red Sunset"	50 - 60'
Red Maple, Bowhall	<i>Acer rubrum</i> "Bowhall"	50 - 60'
Sugar Maple, Green Mountain	<i>Acer saccharum</i> "Green Mountain"	50 - 75'
Hackberry	<i>Celtis occidentalis</i>	50-60'
Marshall's Seedless Green Ash	<i>Fraxinus pennsylvanica lanceolata</i> Marshall's	50 - 60'
Sentry ginkgo (male only)	<i>Gingko biloba</i> Princeton "Sentry"	60 - 70'
Maidenhair tree (male only)	<i>Gingko biloba</i>	50 - 75'
Northern red oak	<i>Quercus borealis</i>	75 - 95'
Willow oak	<i>Quercus phellos</i>	50 - 75'
Redmond American Linden	<i>Tilia americana</i> "Redmond"	75 - 90'
Littleleaf linden	<i>Tilia cordata</i>	70'
Greenspire littleleaf linden	<i>Tilia cordata</i> "Greenspire"	70'
Crimean linden	<i>Tilia euchlora</i>	40 - 60'
Silver linden	<i>Tilia tomentosa</i>	40 - 60'
Japanese zelkova	<i>Zelkova serrata</i>	50'
Green Vase zelkova	<i>Zelkova serrata</i> "Green Vase"	50'
Village Green zelkova	<i>Zelkova serrata</i> "Village Green"	50'

VI. TYPICAL SECTION

A. Paving Section

According to roadway classification, the pavement width shall conform to the width indicated on the Standard Typical Sections.

The minimum depth of the paving section shall be as specified in the Harford County Book of Standard Details, Plates R-1 and R-2.

B. Curb and Gutter

The use of curb and gutter according to roadway classification shall conform to the Standard Details. Permitted use for various types of curb are as follows:

Standard Combination Curb & Gutter:	Any road
Mountable Curb & Gutter:	Any residential road
Bituminous Concrete Extruded Curb:	Temporary installations

C. Permanent, Non-Breakaway Structures in the Right-of-Way

Monumental mailboxes and other ornamental permanent structures are not permitted in the County's right-of-way unless they meet the standards established by the Department of Public Works, the United States Postal Service, and the Department of Planning and Zoning; or, are otherwise explicitly permitted (in writing) by the Department of Public Works.

D. Traffic Barriers

Barriers shall be placed at certain road side obstacles and along embankments where it would reduce the severity of accidents when vehicles leave the roadway. When feasible, embankments shall be adjusted (4:1 or flatter) and/or obstacles shall be removed, thereby eliminating the need for the barrier. Factors under consideration for placement of a road side barrier are design speed, roadway classification (and ADT), roadway geometry, type of obstacle, and distance from the edge of the traveled way.

The clear zone, as identified in the AASHTO Roadside Design Guide and based upon the aforementioned factors, shall be included in the design of the roadways. In the event that the clear zone is unattainable, appropriate barrier treatment shall be installed to guide the errant motorist away from the hazard.

When required, roadside barriers shall be installed in accordance with the AASHTO Roadside Design Guide (latest edition) and the current Maryland State Highway Administration Book of Standards and Specifications and addenda. (See Harford County Standard Details for placement within the typical section.)

E. Sidewalks/Sidewalk Ramps

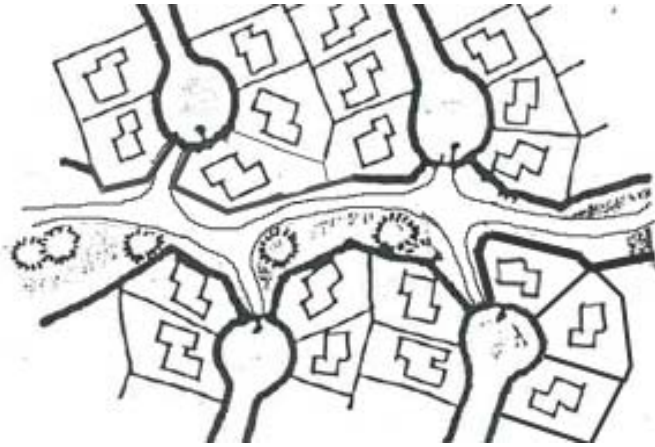
Sidewalks are required along both sides of the roadway unless otherwise specified in this design manual or a waiver is granted by the Department of Public Works, in concurrence with the Department of Planning and Zoning due to average lot size and/or anticipated use. They shall be located one (1) foot from the right-of-way line unless an alternate location is approved by the Department of Public Works. Sidewalks adjacent to areas of perpendicular parking (i.e., town house roadways) shall be six (6) feet in width. (See Standard Typical Section.) Additionally, the cross slope of any sidewalk shall not exceed 1:48.

When the available right-of-way is insufficient to install a five (5) foot sidewalk in conjunction with a fire hydrant (and still maintain the required offset from the road for the hydrant), the sidewalk may be reduced to four (4) feet in width for a distance of five (5) feet to both sides of the hydrant. The sidewalk shall taper to reduced width over a length of five (5) feet.

At the intersection of a closed section roadway with an open section roadway, the sidewalk shall extend to the limits of the curb along the open section roadway or to the edge of the property outside the ditchline of the open section road, as directed by the Department of Public Works.

Sidewalk curb ramps shall be placed at all intersections near the Point of Curve (P.C.) and the Point of Tangent (P.T.) of the curb returns such that perpendicular pedestrian crossing points are created. At a "T" intersection, an additional ramp shall be placed along the top of the tee opposite one of the ramps placed at the corners. At the limit of a sidewalk stub, a ramp shall be placed. Construction of all sidewalk curb ramps shall comply with the ADAAG and/or FHWA requirements, to include the installation of a "brick" or "rust" red color detectable warning device. These devices shall be cast-in-place in conjunction with the construction of the ramp. Surface applied detectable warning devices shall not be permitted on new or reconstructed curb ramps.

As with new roads; sidewalk design and planning shall take into consideration future expansion and interconnectivity of parcels. If, in the opinion of the Departments of Public Works and/or Planning and Zoning, a connection should be made to an adjacent subdivision (or to adjacent roads within the subject community) the developer/engineer shall comply to the extent possible. (See sketch below for a sample trail system linking adjacent cul-de-sacs). As with other sidewalks and pedestrian trails, the connection shall be child stroller/wheelchair accessible and the grade shall not exceed the road grade of any roads within the subdivision.



F. Side Slopes

Side slopes shall conform to Standard Typical Sections. Refer to the "Maryland Standards and Specifications for Soil and Erosion Control" for regulations concerning the treatment of side slopes.

G. Shoulders

Shoulders and their surface treatment shall be as shown on the Standard Typical Sections.

H. Islands and Medians

Islands and medians shall be placed within the roadway only upon approval of the Director of Public Works or his duly authorized agent. Those where width is reduced to less than four (4) feet to accommodate turning movements, shall have a paved surface, while those greater than or equal to four (4) feet shall be seeded and mulched or landscaped with low maintenance vegetation. For landscaped medians, a landscaping plan shall be approved by the Department of Public Works. The long term maintenance of the area shall be the responsibility of the Developer and the HOA and shall be stipulated as such in the HOA Covenants and Restrictions recorded in the Department of Planning and Zoning with the Record Plat for the subdivision.

The road right-of-way width shall be increased by the island width or as directed by the Director of Public Works or his duly authorized agent.

I. Bikeways

Proposed bikeways shall be located beyond the ditch line along an open section road. They shall be located a minimum distance of ten (10) feet beyond the face of curb along closed section roads. They shall be designed as two way facilities with a minimum width of ten (10) feet along all roads classified as residential collector or higher. All other locations may be eight (8) feet in width. Where sidewalk is required, the bikeway may be a combination sidewalk/bikeway along one side of the roadway. The installation of bikeways may be required to interconnect parcels,

adjacent subdivisions, or on residential collector or higher classified roads by either the Department of Public Works or the Department of Planning and Zoning.

J. Signing and Striping

Signs shall be installed prior to acceptance of roadway(s) into the Harford County Road Maintenance System. All "Stop" signs shall be installed in conjunction with the installation of the bituminous base course.

At the entrance to a new roadway, a sign identifying the road as a private roadway and under construction shall be placed. The sign shall be forty-eight (48) inches by forty-eight (48) inches with black lettering on an orange background and shall state "Caution - Uncompleted Road Not Publicly Maintained".

K. Street Lights

Street lights shall be identified on the road plans and shall be installed prior to the acceptance of the roadway(s) into the Harford County Road Maintenance System.

1. County Intersections

Street lights shall be installed at every intersection, at the terminus of a dead end street or cul-de-sac in excess of five hundred (500) feet in length and at any other locations as directed by the Department.

In addition to the aforementioned, street lights shall be installed at five hundred (500) foot intervals along road segments exceeding one thousand (1,000) feet in length or between intersections. For segments less than one thousand (1,000) feet and greater than eight hundred (800) feet in length, a street light shall be installed at the mid-point.

Developments with average lot sizes greater than two (2) acres are not required to provide mid-block street lighting.

Street lights shall be 150 Watt High Pressure Sodium Vapor units for all intersections; and 100 Watt High Pressure Sodium Vapor units for all other locations - unless otherwise directed by the Department of Public Works for specific safety reasons. All lights shall be serviceable by the power company that services the site and the costs for the maintenance of the lights shall be borne by the Developer until the roads are accepted by the County.

Areas defined by the Department of Planning and Zoning as Overlay Districts have additional requirements above and beyond those noted above. If the community is required to install additional lights at their expense and long term maintenance, the engineer shall include a ten (10) foot HOA Tree and Light Maintenance Easement on the plans in which the Homeowner's Association has the authority to install and maintain these additional lights.

2. State Highway Intersections

Street lights at intersections with state highways shall be requested from and coordinated through the Maryland State Highway Administration.

L. Roadside Swales/Ditches

The use of roadside swales and/or ditches shall conform to the Typical Sections.

M. Utility Location

All utility installation plans are subject to the approval of the Department of Public Works prior to the start of construction; initiated in accordance with agreements and/or permits executed between the County and the utility company and/or the Developer and the utility company.

N. Cross Sections and Quantities

When required by the Harford County Department of Public Works, cross sections for roadways and thoroughfares shall be taken at least every fifty (50) feet and at all noticeable terrain breaks. The centerline and profile grade line shall be stationed correspondingly.

The design engineer shall provide quantity estimates for roadways and thoroughfares. These estimates shall include all quantities for grading, paving, curb and gutter, etc., and shall be submitted to the Harford County Department of Public Works, in tabulated form.

O. Under-drain

To drain free water from sub-grades, under-drains shall be incorporated into the design of roadways wherever there is a possibility of water undermining the roadway sub-grade or when concentrated flow (permanent or temporary) is directed across the right-of-way and over the curb. (See Standard Details.)

P. Right-of-Way Width

The right of way width according to roadway classification shall conform to that shown on the Standard Typical Sections.

VII. CONTRACT DRAWINGS

A. Preliminary Reports

For extensive roadway projects, the design engineer shall discuss and illustrate the resulting effect of the project on adjacent property.

B. Contract Drawings

1. General

Roadway layouts shall be prepared along with storm drain plans. These drawings shall be made on standard thirty-four (34) inch by twenty-two (22) inch size double matte mylar and shall be rendered in black ink or pencil.

Drawings produced by computer shall have distinguishing line weights.

2. Title Sheet

A location map drawn to a scale one inch equals six hundred feet (1" = 600') shall appear on the first drawing of the set of plans. The map shall indicate the location of the development by Maryland State System of Plane coordinates, the bench mark, and existing and proposed roads.

The title sheet shall contain General Notes, and Index of Sheets, signature blocks for County officials, the Engineers seal and signature, etc., located on the sheet as designated by the County.

The title sheet shall include the name of the road under construction or improvement and the limits of work described by centerline road station.

3. Plan

a. General

The plan shall be drawn to a scale of 1"=50', 1"=40', 1"=30', or 1"=20'. The plan shall be drawn with north oriented to the top of the page.

Drawing numbers of other utilities (water, sewer, etc.) being prepared for the development at the same time shall be shown on the plan portion of the road and storm drain drawings.

b. Street Names

The names of all roadways shall be clearly lettered either along the street centerline or along one property line. All names on each drawing shall be placed in the same relative position. All names shall be first cleared with the Department of Planning and Zoning as being

available for use (to prevent duplication or similarity of names). Street names shall not exceed twelve (12) letters (including spaces, but not including the suffix).

c. Widths of Right-of-Way, Pavement and Easements

Widths of existing and proposed right-of-way and widths of pavements for each roadway shall be shown with dimensions. Slope easements and utility easements and rights-of-way which intersect roadway rights-of-way shall be shown and dimensioned.

d. Topography

The location of all existing structures and proposed improvements above and below the sub-grade shall be shown. So shall all topography, including poles, trees, fences, hedges, property markers, buildings and other structures. This topography shall be carried at least one hundred (100) feet beyond right-of-way lines, two hundred (200) feet beyond the ends of roadways or beyond approval limits, two hundred (200) feet in each direction from an intersection, and two hundred (200) feet beyond a drainage discharge point. When shown, all measurements for utility structures, poles, trees, fences and hedges shall show dimensions from the roadway centerline. Standard symbols are shown in the Appendix.

e. Coordinates and Bearings

Bearings of roadway centerlines and coordinates of centerline Point of Curves and Point of Tangents and of intersecting roadway centerline Point of Intersections shall be shown along the respective centerlines.

In addition to the above requirements, all Point of Intersections, Point of Curves, Point of Tangents, and other points for the establishment of the centerline of the roadway shall be referenced to permanent features or guarded hub stakes that will not be disturbed prior to completion of all work.

A minimum of three (3) coordinate tics at two hundred fifty (250) foot intervals shall be provided for each plan.

f. Horizontal Curve Information

Centerline curve information for each horizontal curve shall be tabulated on the plan, including:

Angle of intersection (\wedge) ____° ____' ____"

Centerline radius (R) in feet

Tangent Length (T) in feet

Length of Curve (L) in feet

Chord Bearing ____ ° ____ ' ____ "

Chord Length in feet

g. Stationing

Stationing along the centerlines of tangents shall be in even fifty (50) foot stations, indicated on the plans with the station number. Stationing along horizontal curves shall be indicated in like manner.

Point of Curves and Point of Tangents of horizontal curves shall also be indicated on the centerline, and their stations shown to the nearest hundredth of a foot.

Stations of Point of Curves and Point of Tangents of curbs on circular portions of cul-de-sacs shall be shown on the plan.

Point of Intersections of intersecting roadway centerlines shall be indicated at the centerline intersection, and the equality to the nearest hundredth of a foot shall be lettered there under.

Centerlines and traverse lines shall be drawn according to the Standard Symbols in Appendix 1.

h. Match Lines

Roadway plan portions shall be continued from one sheet to the next with match lines.

i. Points of Intersection of Curb Lines

The points of intersection of curb lines shall be indicated by small linked crosses, and shall be identified there under as N.E., N.W., S.W., or S.E.

j. Direction of Drainage

Arrows approximately one-half (1/2) inch long shall be drawn around all curb returns and all critical drainage points to indicate the direction of surface water flow in ditches or gutters.

Wherever the slope of a gutter is reversed from the roadway slope, a note and symbol to that effect shall appear on the plan.

When an inlet adjacent to a curb return is to be set to an elevation that serves as the low point along the curb return and the grades of the intersecting roadways are not a true picture of the top curb grade in the inlet area, then a note shall appear on the plan stating that the top curb grades in the inlet area shall be set in the field to locate the sump at the inlet.

Proposed grading within the intersection and in cul-de-sacs shall be provided when requested by the Department of Public Works.

k. Storm Drainage

The design engineer shall indicate on the roadway plans all of the proposed storm drainage system.

l. Grading

A final grading plan shall be submitted with the roadway construction documents. This plan shall include grading within a minimum of fifty (50) feet to each side of the roadway centerline. The grading along the existing roadway or the future roadway shall extend for two hundred (200) feet minimum.

4. Profiles

a. General

The profile shall be drawn to a horizontal scale of 1" = 50' and a vertical scale of 1" = 5'. The profile grid shall be designed for a corresponding fifty (50) and five (5) scale.

b. Profile Grade

The profile grade submitted for approval shall be shown and designated as the Profile Grade Line (P.G.L.). On profiles where the grades are warped, one grade shall be shown by a solid line with a note designating each.

Circles, as shown in the Standard Symbols, shall be used on Profile Grade Line to designate vertical curve Point of Vertical Curves (P.V.C), Point of Vertical Reverse Curves (P.V.R.C.), Point of Vertical Concentric Curves (P.V.C.C.), and Point of Vertical Tangents(P.V.T.). A triangle shall be used to designate the Point of Vertical Intersections.

All percents of grades shall be shown to two decimal places.

c. Previously Established Top of Curb Grade and Centerline Grade

Where grade line shown on a drawing is taken from a previously established grade, it shall be designated as "established P.G.L.". The date established and the design drawing number of such previously established grades shall be noted on the profile. On existing pavement, grades shall be field surveyed and the date of the field survey noted.

d. Existing Ground Profiles at Centerlines and Property/Right-of-Way Lines

The profile of the existing ground along the centerline of a proposed roadway and the profile of the existing ground line along property/right of way lines shall be shown by dashed lines as indicated in the Standard Symbols. The existing ground profiles shall be so labeled, and the date of the field survey shall be indicated.

e. Vertical Curves

A vertical curve shall be shown on profiles as a smooth curve between tangents. Curve information for each vertical curve shall be tabulated on the profile, including:

Point of Vertical Intersection (P.V.I.) Station

Point of Vertical Intersection (P.V.I.) Elevation

Length of Curve

Correction at the Point of Vertical Intersection (P.V.I.)

Algebraic Difference

Headlight/Stopping Sight Distance

f. Top of Curb Grades for Cul-de-sacs

Top of curb grades for cul-de-sacs shall be shown independently as profiles running linearly around the perimeter of the cul-de-sac including the approach returns.

An additional one hundred (100) foot overlap on each end of the linear profile shall be shown.

g. Top of Curb Grade of Intersecting Streets

Top of curb grades for standard curb returns of intersecting streets normally need not be shown as linear profiles around the curb circumference, but shall be shown as profiles along the horizontal tangents from the Point of Curves of the curb lines to the Point of Intersections of the curb lines.

Where returns exceed a fifty (50) foot radius or when a drainage problem is evident, top of curb grades shall be shown independently as profiles running linearly around the circumference of the curb line; as directed by the Harford County Department of Public Works.

h. Stationing and Elevations

Stations of all points of intersection of curb lines and pavement edges shall be determined at right angles to the centerline. Therefore, a face of curb line shall not be extended to intersect a centerline at a skew in order to establish a station.

Throughout profiles, elevations shall be shown for each fifty (50) foot station with additional elevations every twenty five (25) feet throughout vertical curves.

Elevations on tangents shall be computed. Elevations on vertical curves shall be computed. Elevations shall be shown to the hundredths of a foot.

Where curbs are warped, separate elevations shall be given for each curb and shall be identified as N.T.C., S.T.C., E.T.C., and W.T.C.

Stationing and elevations shall be shown for all curb return Point of Intersections and vertical curb Point of Curves and Point of Tangents. Points of Intersection of curb lines shall be designated NEPI, NWPI, SEPI, and SWPI to correspond with the plan.

i. Extension of Profiles

At any point where a proposed roadway is an extension of an existing roadway, the profile of the existing roadway shall be shown for at least another two hundred (200) feet and the heights of the Profile Grade Line (P.G.L.) noted along with the date of survey. All roadway profiles shall be extended a sufficient distance and shall never be less than two hundred (200) feet beyond the approval limits requested except in the case of a profile terminating at a tee intersection. These profiles shall be independent and shown apart from the proposed top curb profile or profiles.

i. Profiles of Alleys and Entrances to Parking Areas

Where such profiles are required by the Harford County Department of Public Works, these profiles shall show the finished centerline grade for all alleys and entrances to parking areas independently and apart from the profiles of proposed streets and thoroughfares. They shall be clearly labeled.

5. Typical Sections

Typical sections of each type of proposed roadway (i.e. paving width and/or right-of-way width) to be constructed shall be shown once on each set of construction drawings. These sections shall be shown on the detail sheet with corresponding road names and stations for which they are applicable. These sections shall identify the Profile Grade Line (P.G.L.). These sections shall conform with the typical sections, shown in the Standard Road and Street Details, unless otherwise directed by the Harford County Department of Public Works.

6. Cross Section

At the request of the Department of Public Works, on all improvements to existing roads and where a subdivision abuts on only one side of a road, cross sections shall be taken in the field. The maximum distance between cross sections shall be fifty (50) feet with intermediate cross sections taken, as needed, to show a true picture of the topography. The cross sections shall extend to a point sufficient to determine the slope and other easements. The cross sections shall be plotted on standard cross section paper; ten by ten (10 x 10) graduations to the inch. The scale for plotting the cross sections shall be one inch equals five feet (1" = 5') both vertically and horizontally. For very steep slope conditions or extremely wide cross sections, a scale of one inch equals ten feet (1" = 10') may be used. The original ground line shall be in ink and the proposed road section in pencil.

7. Check List

The design engineer shall use the check list as an aid to determine whether or not the listed items have been properly completed on the plan. One copy shall be submitted to the County with the plans.

8. Stakeout and Grade Sheets

All construction work to be done under Harford County contracts shall be completely staked out. Grade sheets shall be submitted to the Harford County Department of Public Works to meet the following requirements:

- a. Where there is curb and gutter, or mountable curb, separate grade sheets will be submitted for each curb.
- b. Where there is no curb and gutter or mountable curb, a grade sheet for the centerline grade shall be submitted.
- c. When storm drainage is included under the roadways contract, a separate grade sheet for storm drainage shall be submitted.

Stakeout shall conform to stationing shown on the plans and profiles. Horizontal curve points and radius points of returns shall be staked, and stakes shall be required at fifty (50) foot stations on tangents and twenty five (25) foot stations on horizontal and vertical curves.

Line and grade shall be staked one hundred (100) feet beyond construction limits in areas where there is no existing curb or paving.

Grade sheets shall be eight and one-half inches by eleven (8 ½ x 11) inches, either typewritten sheets or prints from a tracing, and shall comply with the Standard Form for Grade Sheet (Standard Details).

A separate grade sheet shall be submitted for each curb or other line of construction. Grade sheets shall show stations, elevations of both grade stake and finished construction, and offsets to construction lines as well as cuts and fills.

C. Contract Specifications

Proposed work not covered by Harford County Specifications shall be covered by supplementary contract specifications.

D. Estimate of Quantities

The design engineer shall furnish estimates of all quantities and costs including contingent items to complete all work as shown on contract drawings. These shall include but not be limited to road construction, drainage facilities, soil and erosion control measures and storm water management facilities.

E. Design Calculations

The design engineer shall submit design calculations along with the contract drawings.

F. Temporary Easement Plats

Work done outside of existing public road rights of way or easements or outside of those roads and easements to be shown on the final subdivision plat(s) shall be accompanied by supplementary temporary easement plats. Failure to furnish shall result in the delay of plan approval.

SECTION II

HARFORD COUNTY DEPARTMENT OF PUBLIC WORKS STORM DRAIN DESIGN STANDARDS

SECTION II
HARFORD COUNTY
DEPARTMENT OF PUBLIC WORKS
STORM DRAIN DESIGN STANDARDS

I.	GENERAL.....	D-1
A.	Introduction.....	D-1
1.	Capital Projects	D-1
2.	Development Projects	D-1
II.	HYDROLOGY	D-1
A.	Rational Method	D-1
B.	Rainfall Intensity (I).....	D-2
C.	Runoff Coefficient (C).....	D-2
D.	Time of Concentration (TC)	D-2
E.	Area (A)	D-3
F.	Special Considerations.....	D-3
III.	HYDRAULICS.....	D-3
A.	General.....	D-3
1.	Storm Water Runoff.....	D-3
2.	Determination of Conveyance Size	D-3
3.	Open Channels versus Closed Conduits	D-4
B.	Closed Conduit Design	D-4
1.	Storm Frequency	D-4
2.	Size of Storm Drains	D-4
3.	Velocity.....	D-4

4.	Hydraulic Grade Line (Hydraulic Gradient).....	D-4
a.	Slope of the Hydraulic Gradient	D-5
b.	Head Losses in Structures	D-5
5.	General Limitations	D-6
6.	Location of Drains	D-7
a.	In New Subdivisions	D-7
b.	In Existing Developments	D-8
c.	In Parks or Public Rights-of-Way	D-8
7.	Inlets.....	D-8
a.	Type	D-8
b.	Spacing.....	D-8
c.	Capacity	D-9
d.	General.....	D-9
8.	Manholes and Other Drainage Appurtenances	D-10
a.	General.....	D-10
b.	Manholes.....	D-10
c.	Bend Structures, Junction Chambers	D-10
9.	Pipe Curves	D-11
10.	Materials	D-11
11.	Clearance	D-11
12.	Structural Considerations.....	D-11
a.	Pipe Loading	D-11
b.	Pipe Joints	D-11
c.	Reinforced Concrete Box Drains	D-11
d.	Special Structures	D-12
e.	Foundations.....	D-12
f.	Underdrains.....	D-12
C.	Open Channels (Streams, Ditches, Swales, Etc.)	D-12
1.	Roadside Ditches	D-12

2.	Open Channels	D-13
3.	Natural Channels.....	D-14
D.	Outfalls.....	D-14
1.	Suitability	D-14
2.	Design	D-14
E.	Culverts, Bridges and Miscellaneous Structures	D-14
1.	Structure Waterway Opening.....	D-14
a.	Hydrologic Design	D-14
b.	Hydraulic Design	D-14
2.	Structural Design	D-15
IV.	CONTRACT DRAWINGS	D-17
A.	Preliminary Reports	D-17
B.	Contract Drawings	D-17
1.	Plan	D-17
a.	Scale.....	D-17
b.	Method of Indicating Location	D-17
c.	Easements	D-18
2.	Profile.....	D-18
a.	Scale.....	D-18
b.	Street Grades	D-18
c.	Hydraulic Gradient	D-18
d.	Notes	D-19
3.	All Existing and Proposed Utilities	D-19
4.	Location and Design Information	D-19
5.	Special Details	D-19
6.	Structure Schedule	D-19
C.	Estimate of Quantities.....	D-19

D.	Design Calculations	D-20
1.	Hydraulic Design	20
a.	Flow Tabulation Form	20
b.	Calculation of Stormdrain, Ditches, Culvert, Hydraulic Gradient, etc.....	20
2.	Structural Design	20
a.	Drains.....	20
b.	Special Structures	20
3.	Coordinates	20
4.	Results of Borings and Test Pits	20

**SECTION II
HARFORD COUNTY
DEPARTMENT OF PUBLIC WORKS

STORM DRAIN DESIGN STANDARDS**

I. GENERAL

A. Introduction

Drawings and documents for Public Works Projects shall be prepared in accordance with instructions contained in this manual and shall be classified as follows:

1. Capital Projects

Capital Projects shall be considered as those projects where the subdivision of property is not primarily involved. These projects are initiated through the Department of Public Works and shall be designed in accordance with criteria established by the Department.

2. Development Projects

Development Projects shall be considered to be those projects where the subdivision of property is primarily involved or where the development of a site requires road and drainage improvements. These projects are processed under the Subdivision Regulations as issued by the Office of Planning and Zoning with the roads and streets designed in accordance with criteria established by the Department of Public Works.

II. HYDROLOGY

A. Rational Method

The rational formula $Q=CIA$ shall be used to determine quantities of runoff for drainage areas except for areas over one hundred (100) acres where other methods may be used subject to the approval of the Harford County Department of Public Works. For areas greater than one hundred (100) acres, the Soil Conservation Service TR-20 and TR-55 computer programs are recommended.

In the Rational Formula,

- Q = Quantity of storm water runoff in cubic feet per second at the point of investigation
- C = Runoff coefficient based on ground cover, soil condition and slope
- I = Intensity or rate of rainfall in inches per hour – ‘I’ is dependent upon the time of concentration (t_c) and the storm frequency used.

A = Tributary area in acres

B. Rainfall Intensity (I)

Rainfall intensities for the required design frequency and appropriate time of concentration shall be obtained from the appropriate charts.

C. Runoff Coefficient (C)

The runoff coefficient, used in computing flow to a point under consideration, shall be a composite of the 'C' factors for all the areas tributary to this point. In areas where the nature of future development is uncertain, design engineers shall consider future development in accordance with the Department of Planning and Zoning "Land Use Element Plan".

Design engineers shall determine 'C' factors from field inspection of area and consideration of type of soil and average slopes of tributary areas. 'C' factors for developments shall represent a weighted average of the areas.

Use the appropriate chart to develop composite 'C' factors for typical residential subdivisions.

D. Time of Concentration (TC)

The time of concentration is the period of time required for water to flow from the hydraulically most distant point within the tributary area, to the point under consideration. The time of concentration must be based on the ultimate storm drain system. The time of concentration must accurately represent the drainage area under consideration. The time of concentration is the sum of the inlet time and the time of flow in drains to the point of investigation. These times shall be rounded to the nearest 0.1 minute for drainage computations. Times of concentration must be determined using the methods described in this manual.

Inlet time is the combined time of overland flow and flow in swales, gutters and ditches to the inlet.

The minimum inlet time shall be five (5) minutes.

Time of flow overland, in swales, in ditches, in gutters and in drains, shall be determined from the relationship,

$$\text{time} = \frac{\text{distance}}{\text{velocity}}$$

The velocity shall be determined by the Manning formula.

Overland flow is sheet flow across lawns, graded areas, fields and paved areas. A maximum overland flow distance of seventy-five feet (75') shall be used. The time of concentration for overland flow shall be determined by using the appropriate chart.

Swale flow velocities shall be calculated by the Manning formula using tabulated values for ground cover: see the appropriate chart.

Stream flow velocities shall be determined by using the appropriate chart.

Gutter flow velocities shall be determined using the nomograph on the appropriate chart.

Full flow conditions will be used to determine drain times within the system.

Drain times may be estimated using seven feet per second (7 fps) for existing or future storm drains and four feet per second (4 fps) for swales; subject to the approval of the Department of Public Works.

E. Area (A)

The area is the size of the drainage area measured in acres.

The limits of the contributing off-site area shall be considered based upon “Land Use Element Plan” and information from approved plans. Should approved plans not be available, areas shall be determined using existing ridge lines.

F. Special Considerations

Where intensity values (associated with the time of concentration based on travel time) may decrease faster than the total area of the watershed increases, a decrease in the product of intensity times area will result in a decrease in the peak runoff. The runoff shall not be decreased and the greatest upstream value of peak runoff shall be used until a point is reached where the peak runoff rate increases again.

III. HYDRAULICS

A. General

1. Storm Water Runoff

Storm water runoff is collected and conveyed in closed conduit systems (inlets, manholes and storm drains) and open channel systems (ditches, culverts, improved open channels, streams and rivers.) Instructions for design of Closed Conduit Systems and Improved Open Channels are contained in this section. Instructions for design of culverts are contained in Bridges and Culverts Section.

2. Determination of Conveyance Size

Manning's formula is to be used to correlate velocity, slope and friction for the determination of the size of the storm drain or open channel to convey the calculated flows. The standard tabular

form may be used for pipe computations. Swale tabulations will be provided with open section roadway design.

3. Open Channels versus Closed Conduits

Where the volume of flow from rainfall runoff would require drain sizes larger than forty eight inches (48"), the flow shall be conveyed in improved open channels, wherever possible.

B. Closed Conduit Design

Drain sizes shall be established based on many factors: terrain, land use, relative location within a watershed, pipe materials, hydrology, flow quantities, etc. For design, the hydraulic grade line method will be used as herein described.

1. Storm Frequency

The runoff from a ten (10) year storm frequency shall be used in the design of closed conduit systems.

2. Size of Storm Drains

The size of drains shall be determined by the equation:

$$Q = av \text{ where :}$$

Q = quantity of flow in cfs

a = required area of conduit in square feet

v = velocity in feet per second

3. Velocity

Velocity shall be determined by the Manning formula:

$$v = \frac{1.486}{n} r^{2/3} s^{1/2}$$

where:

n = coefficient of roughness (See appropriate chart.)

r = hydraulic radius in feet = $\frac{\text{cross-sectional area}}{\text{wetted perimeter}}$

s = slope of the hydraulic gradient in feet per foot

4. Hydraulic Grade Line (Hydraulic Gradient)

The hydraulic grade line (h.g.l.) is a line connecting points to which water will rise in manholes and inlets throughout the system during the design flow. The hydraulic gradient shall be determined starting at the downstream end of the proposed drainage system.

- Where a proposed drainage system is connected to an existing drainage system the hydraulic gradient at the point of junction shall be determined from the hydraulic gradient computations of the existing drain on file at the Department of Public Works. Where no drawings or computations indicating the elevation of the existing hydraulic gradient are on record with the Department, it shall be the designer's responsibility to determine the elevation. Connections to inadequate drainage systems shall not be allowed.
- Where the proposed drainage system discharges into a stream, improved channel or storm water management pond, the tailwater conditions of the outfall shall be investigated. Where the tailwater elevation is higher than the proposed crown elevation, the hydraulic gradient shall begin at this tailwater elevation.
- Where free outfall conditions exist, the hydraulic gradient shall begin at the crown of the proposed drain.

The friction slope is then calculated, based on the Manning equation and carried to the next upstream structure.

- If the friction slope intersects the normal depth of flow within the pipe, that depth shall be added to the upstream invert and shall be the incoming h.g.l. Normal depths may be calculated using the appropriate chart.

Next, the structure losses shall be added to the h.g.l. elevation of the outgoing pipe at the structure.

- This elevation shall be compared to the depth of flow in the upstream pipe. The highest elevation shall be used as the hydraulic gradient elevation at the structure.

This process is repeated until the top of the system is reached.

The hydraulic gradient for the design flows shall not be above an elevation of 1'-6" below the established street grade nor more than 1' over the crown of the pipe.

a. Slope of the Hydraulic Gradient

Friction slope is calculated by the Mannings equation:

$$S_f = (nv)^2 / 2.2082r^{4/3}$$

or by use of conveyance factors which have been derived using Manning's equation. (See appropriate chart.)

b. Head Losses in Structures

Structure losses shall be computed by the following formula::

$$H_b = \frac{K_b V_f^2}{2g}$$

where:

H_b = Headloss (in feet)

K_b = Headloss coefficient

V_f = Frictional Velocity in the outlet pipe (in feet per second).

g = Acceleration due to gravity (in feet per second, per second)

The magnitude of the structure loss is dependent on the type of structure (i.e. inlet, manhole, or bend) and the angle between the incoming and outgoing pipes. This loss may also be determined by the appropriate chart. The structure loss at a field connection is the same as that for a manhole.

For application and determination of these losses, see appropriate charts.

5. General Limitations

The minimum size of storm drain shall be fifteen inches (15").

The design engineer has the option of using either reinforced concrete pipe, Type 2 aluminized corrugated metal, corrugated aluminum pipe or, high density polyethylene pipe, for storm drain systems within the County right of way. Note that High Density Polyethylene pipe shall not be used under a County maintained closed section roadway. The minimum cover over pipe shall be eighteen inches (18") measured between the crown of the pipe and the finished grade. When the pipe passes underneath pavement, twelve inches (12") measured from the crown of the pipe to the top of the subgrade shall be required.

Corrugated metal pipe and high density polyethylene pipe shall have minimum cover as designated in Appendix II "Cover Requirements for Corrugated Metal Pipe." In no case, shall this cover be less than eighteen inches (18") under the roadway

Pipe sizes shall not be reduced in the direction of flow.

To facilitate the change of pipe size within a structure, the elevations at the crowns of the pipes shall normally be equal.

Velocities shall not exceed twenty five feet per second (25 fps) for actual flow conditions in any pipe section.

Structures receiving flows with velocities equal to or in excess of twenty feet per second (20 fps) shall have granite inverts and investigated for side treatment.

Structures with a drop of six feet (6') or greater shall have granite inverts.

The minimum slope of the invert of structure shall be four percent (4 %). The slope of the invert shall be increased as required to ensure a minimum two tenths of a foot (.2') difference between the invert-in and the invert-out of a structure.

Pipe grades shall be limited to twenty percent (20%) without an approved anchorage system. The minimum pipe grade shall be one percent (1%) for an eighteen inch (18") pipe or smaller (to enhance self cleaning characteristics) and shall be one half percent (.5%) for all other diameters.

Deflection angles shall not exceed ninety degrees (90°).

All enclosed systems shall be designed so that they will generally operate without hydrostatic pressure. Should the hydraulic gradient elevation exceed the elevation of the crown of the pipe by one foot (1'), the joints shall be made water tight by the use of flanges with gaskets, coupling bands made with gaskets, bell and spigot ends with gaskets, by welding, or by approved manual recommendations. Construction specification with details shall be shown on the plan.

Full consideration should be given to the possible future extension of the system based on ultimate development.

Private drainage systems when connected to a County stormdrain system shall be connected by an accessible structure.

Public drainage systems shall be established when transmitting off site runoff through a site; at the discretion of the Director.

6. Location of Drains

a. In New Subdivisions

Storm Drains shall normally be installed along the edge of the roadway or, for closed section roads, behind the curb. In town house developments, storm drains shall be placed in the roadway where there is parking on both sides of the road. Where there is parking on one (1) side only, the storm drain shall be placed behind the curb along the side with no parking.

Where located outside of the road right of way, storm drains shall be located within drainage and utility easements. Minimum widths of easements shall be governed by drain size as follows:

15" to 24" diameter	20 feet
27" to 48" diameter	25 feet
54" to 72" diameter	30 feet

Where no drains are present, a minimum side lot line easement of seven and one half feet (7.5') and a minimum ten foot (10') rear lot line easement shall be provided. Additional easements shall be provided as directed by the Department of Public Works.

b. In Existing Developments

In existing developments, drains shall generally be located as discussed above. However, the location of other existing and proposed utilities and traffic conditions shall be fully considered in determining the location of drains.

c. In Parks or Public Rights-of-Way

Where location of drains would require removal of or damage to trees within parks or public rights-of-way, design engineers shall obtain approval of the State Department of Forestry for drain alignment and trees to be removed.

7. Inlets

a. Type

"Combination inlets" (grates and curb openings) shall be used on streets with existing or proposed curbs. Inlets with curb opening only shall be used only where existing utilities preclude placement of grates within the pavement. Inlets without deflectors shall be selected, in accordance with required capacity. Inlets shall not be depressed in traffic lanes. See Standard Details for type, size and limitations.

b. Spacing

Maximum spacing of inlets for drains eighteen inches (18") or smaller shall be two hundred fifty feet (250'). Maximum spacing of inlets for drains twenty one inches (21") to twenty seven inches (27") in diameter shall be four hundred feet (400'). Maximum spacing for inlets for drains greater than or equal to thirty inches (30") in diameter shall be six hundred feet (600'). Stated limitations shall apply to arch or elliptical pipe equivalents.

Inlets shall be constructed at all sumps and at all intersections where conditions of street crown and/or quantity of flow would require an inlet. Inlets shall be spaced so that gutter flow limitations as described below are not exceeded.

The spread of flow in curbed sections shall not exceed ten feet (10'), with the exception of a sump condition on a roadway equal to or greater than thirty feet (30') in width, where the maximum permissible spread shall be twelve feet (12'). Spread shall be determined based upon

the 'Q' for the ten (10) year storm. In a sump area, the spread shall be determined based upon the 'Q' to the sump for the twenty (20) year storm.

The depth of ponding shall not exceed the height of the curb.

c. Capacity

Inlet capacities based on the ten (10) year storm shall be determined by using the appropriate chart, taking into consideration street grades, road cross slopes, gutter capacities and permissible spread of surface flow in the gutter.

Inlets shall be selected as to type and spacing to intercept a minimum of eighty five percent (85%) of the design storm.

Sump inlets shall be sized for the twenty (20) year storm rainfall intensity. Inlet capacities shall be determined by using the appropriate charts, when available.

When charts are not available, an inlet grate may be evaluated using the following formula:

$$Q = 3.0 (PH^{3/2})$$

where

Q = Capacity (in cubic feet per second)

P = perimeter of grate opening (ignoring bars) (in feet)

h = head over grate (in feet)

This formula is strictly applicable only where h is less than 0.4 feet. In order to compensate for clogging, grate inlets (with no curb opening) will be designed with the assumption that only 75% of the total grate perimeter is usable. If the grate is adjacent to the curb, the perimeter will first be reduced by the length of the side at the curb and will then be multiplied by 75% to get the length of perimeter for design.

Combination inlets in sump areas will be designed with the full usable perimeter and the curb opening will be considered as a factor of safety against clogging.

A grading plan shall be submitted to include a flow bypass area for sump inlets. The area shall be designed for the ten (10) year storm with one hundred percent (100%) clogging of the inlet. The area shall be located within a drainage and utility easement.

d. General

Inlets at intersections shall be upgrade from all p.c. 's/p.t's of the curb return. The inlet headpiece shall remain in the tangent portion of the curb. An inlet will be required upgrade of a road intersection or a commercial entrance if the gutter flow crossing the intersection exceeds one cubic foot per second (1 cfs). Minimum and maximum depths shall conform to the Standard Details.

8. Manholes and Other Drainage Appurtenances

a. General

General Criteria for manholes, cut-ins, wye branches, brick bends (with or without connections) and Junction Chambers can be found on the appropriate chart which illustrates the typical use and limitations.

Minimum and maximum depths shall conform to the Standard Details.

b. Manholes

Manholes shall be used at all changes of pipe size, direction, and grade. Maximum spacing of manholes for drains eighteen inches (18") or smaller shall be two hundred fifty feet (250'). Maximum spacing of manholes for drains twenty one inches (21") to twenty seven inches (27") in diameter shall be four hundred feet (400'). Maximum spacing for manholes for drains greater than or equal to thirty inches (30") in diameter shall be six hundred feet (600'). Stated limitations shall apply to arch or elliptical pipe equivalents.

The frame and cover of the manhole outside the travelway shall be located entirely within sidewalk or entirely out of sidewalk area.

c. Bend Structures, Junction Chambers

Bend structures and junction chambers shall be utilized in place of type 'A', type 'B' and/or type 'C' manholes when the 'D' angle exceeds the following:

Max. Δ° , 'A' or 'B' manhole = $1375 / \text{pipe diameter (inches)}$

Max. Δ° , 'C' manhole = $1719 / \text{pipe diameter (inches)}$

Design Criteria:

The minimum centerline length shall be four (4) feet. The radius of the arc shall be determined using two (2) times the diameter of the upstream pipe. Bend structures or junction chambers shall be utilized in place of a 'C' type manhole when the centerline length is greater than or equal to four feet (4').

The use of a 'C' manhole as a substitute for a bend structure or junction chamber for pipe sizes less than forty two inches (42") shall not be permitted.

Box sections must have a centerline radius of twice their width to facilitate a change in direction.

Manhole stacks on box structures, bends and junction chambers are required.

Precast structures, as substitutes for the above, must comply with their respective geometrical configurations and be produced to the same specifications as the pipe or box section they compliment.

Type I junction chambers shall be used for forty eight inches (48") in diameter and smaller pipes where actual velocities are less than fifteen feet per second (15 fps). Special junction chambers shall be used where velocities exceed fifteen feet per second (15 fps) or the largest pipe exceeds forty eight inches (48"). They shall be of special design, detailed on plans and streamlined to limit head losses.

9. Pipe Curves

Horizontal and vertical pipe curves shall not be used.

10. Materials

The materials acceptable for storm drain construction and their corresponding roughness coefficient, 'n', to be used in the solution of the Manning Formula can be found in the appropriate chart.

11. Clearance

Storm drains in relation to water mains shall be constructed with a minimum horizontal clearance of 5 feet and a minimum vertical clearance of 1 foot. Storm drains in relation to sanitary sewers shall be constructed with a horizontal clearance to be determined on a case-by-case basis by the Department of Public Works, however, this clearance shall be no less than 5 feet. Vertical clearance with sanitary sewers shall be a minimum of 1 foot.

12. Structural Considerations

a. Pipe Loading

Minimum and maximum permissible depths shall be in accordance with the appropriate charts. However, these depths shall not be less than depths discussed under General Limitations.

b. Pipe Joints

The design engineers shall be responsible for the specification of special joints based upon soil conditions.

c. Reinforced Concrete Box Drains

Reinforced concrete box drain structural design shall be in accordance with structural design of culverts as discussed in the Culverts, Bridges and Structural Design Section.

d. Special Structures

Allowable stresses and method of considering loads for special structures (junction chambers, etc.) shall generally be in accordance with structural design of culverts as discussed in the Structural Design Section.

e. Foundations

In all cases, proper foundations shall be provided for drains. Design engineers shall detail in contract drawings methods acceptable to the Department of Public Works for supporting drains on unstable ground or fill.

f. Underdrains

Underdrains need not be shown on the contract drawings, except as designated for areas of concentrated flow over curb as described under the Roadway Design Section.

C. Open Channels (Streams, Ditches, Swales, Etc.)

Design computations shall be provided for all channels, accompanied by a typical section of each reach and a plan view with typical sections clearly marked. In the case of existing streams or swales which are to remain in natural condition, field run survey data and engineer analysis is necessary to prove the streams will remain in stable condition. The design engineer shall clearly document the condition of the natural channel during design; especially at outfalls.

1. Roadside Ditches

Generally, the use of these criteria for roadside ditches shall be used in connection with the design and the construction of new open section residential roadways. However, the criteria may be applied in other cases; existing roads without curb and gutter and median ditches.

Ditches are considered integral components of the public drainage system. Roadway ditches shall be 'V' or flat bottom ditches shaped in accordance with Harford County Department of Public Works Standard Details. Other channel cross sections will be considered for approval under certain conditions, e.g., along existing roadways when the standard 'V' ditch design will not meet existing conditions. They shall be designed to provide

sufficient hydraulic capacity to convey the estimated runoff from a ten (10) year frequency storm at a non-erosive manner. The estimated runoff shall be calculated using the methods described under the Hydrology Section.

Ditch capacity shall be calculated using Manning's formula. The appropriate roughness coefficient for the ditch lining under consideration shall be selected from the appropriate chart.

The minimum acceptable grass ditch gradient is one percent (1%).

The maximum permitted depth of flow for the typical side ditch shall be one foot (1') with a minimum freeboard of one half foot (0.5') from the top of the side ditch. Driveway and street culverts may cause backwater in excess of one foot (1'). However, the typical swale section must carry the design flow with one foot (1') of depth in absence of the culvert. When this depth is exceeded, the runoff must be intercepted by appropriate storm drain inlets and conveyed in a pipe from that point to an acceptable outfall.

In those situations where the introduction of an enclosed storm drain system is not feasible and with prior approval of the Department of Public Works, a change in the ditch section characteristics may be permitted. Except at driveway crossings and street crossings where the outlet conditions allow for ditch flow, i.e., depth does not exceed one foot (1'), enclosed pipe systems may be used in lieu of culverts.

The design plans for any roadway having a roadside ditch shall show for the ten (10) year design storm the velocity in fps, depth of flow in feet, and quantity of flow (Q) in cfs for the ditch on all sides of every intersection, at three hundred foot (300') intervals of the centerline road length, on the uphill side of all inlets, on each side of the ditch leading into a sump or at any other critical locations where ditch flow is significantly affected by either increased drainage area and/or change in street or ditch gradient. (See sample ditch chart.)

2. Open Channels

Open channels are recommended to convey stormwater when the discharge is greater than the capacity of a forty eight inch (48") pipe. When used, they must be designed to carry the design year storm with a minimum freeboard of six inches (6") to the top of the channel. Velocities in earth and sodded channels must be such that erosion will not occur.

Computations shall include slope, cross section, roughness coefficient, velocity, and quantity of discharge for each section of pipe or reach of channel. A gabion or rip rap protected invert shall be provided when base flow is present.

3. Natural Channels

These channels must be stable and remain stable under the ultimate development of the watershed. Computations shall be provided for the existing and ultimate flow quantities and velocities.

D. Outfalls

1. Suitability

The design engineer shall be responsible to design an adequate outfall. The outfall must handle design flow without adverse impact on the point of discharge or any point further downstream. The Department of Public Works will approve the level of the analysis at the time of preliminary plan review.

2. Design

Outfalls shall be designed in accordance with the Soil Conservation Service method for rip rap outlet protection.

E. Culverts, Bridges and Miscellaneous Structures

Large culverts (> 60" in diameter) shall be submitted for review at the very earliest design stage and must be preliminarily approved by the Department prior to submitting road and storm drain plans for 1st review. Significant stream channels shall utilize a bridge, sunken box culvert or arch structure to convey the flow of water. Failure to obtain this initial approval may result in the set of plans being returned to the engineer, without review, when submitted.

1. Structure Waterway Opening

a. Hydrologic Design

Design stream flows shall be calculated using the TR-20 computer program for drainage areas over 100 acres. The TR-55 manual calculation method may be used for areas under 100 acres.

b. Hydraulic Design

Roadway culverts and bridges, exclusive of driveway culverts, shall be designed to pass the one hundred (100) year frequency storm. Design Q's shall be based on the "Land Use Element Plan."

The maximum water surface elevation for the one hundred (100) year frequency storm shall be measured: 1) top of curb for closed section roads, and 2) top of the edge of the shoulder for open section roads. Values of H_w/D shall be limited to 1.5 for the design storm.

The design computations for culvert hydraulics shall be in accordance with H.E.C.-2, H.E.C.-R.A.S. 5, HY-8 or other methods with approval by the Department of Public Works. All structures over water shall be designed to resist stream or tidal scour, using the latest SHA and Federal guidelines.

Driveway culverts shall be designed to pass the ten (10) year storm based on the above hydraulic parameters and methods.

2. Structural Design

Structures which are modified or beyond the standard limit must be designed by a professional engineer registered in the State of Maryland and checked for structural adequacy by the Department of Public Works.

Computations, using either the ultimate or working stress methods, design assumptions, parameters, and geotechnical support data shall be submitted to the Department of Public Works, signed and sealed by a professional engineer registered in the State of Maryland. Designs must be approved on a case-by-case basis.

New and modified bridges, culverts, and other non-standard roadway structures, shall be designed by a professional engineer, registered in the State of Maryland. The latest edition (including interim updates) of the below listed references shall be used in the design. However, the engineer may use other pertinent industry standard references with the approval of the Department of Public Works.

Standard Specifications for Highway Bridges (latest edition and interim specifications), American Association of State Highway and Transportation Officials (AASHTO).

Policy and Procedures Manual, and Structural Standards Manual, Maryland Department of Transportation, State Highway Administration, Division of Bridge Development.

Standard Specifications for Construction Materials, Maryland Department of Transportation, State Highway Administration.

The engineer shall submit all computations, using the ultimate strength or working stress method to the Department of Public Works along with the

PS&E submission. This submission shall include design assumptions as well as pertinent design data. The Department of Public Works may request selected portions of the computations to be submitted anytime prior to the PS&E submission, to facilitate the review process during any stage of design. The type and number of submissions will be determined at the preliminary plan approval (DAC).

The engineer shall also submit live load rating calculations for all bridges, culverts, and other structures that are over an 8 feet span along the centerline of the road. The rating vehicles include the H-15, HS-20 and T-3 Standard Maryland Vehicles. The rating calculations shall be completed, using the ultimate strength design method as required by the State Highway Administration. The structural capacity of all of the live load carrying members shall exceed the factored Inventory Stress for each member.

Designs that will cause a structure to be posted for any of the rating vehicles will be considered substandard. (Note: Modifications of existing structures may result in a posted structure with written approval of the Director.) All substandard members must be redesigned to yield an unposted structure.

Structural Inventory and Appraisal Forms as well as Pontis Element Data Forms shall be completed and submitted to the Department of Public Works for all structures over an 8 feet span, along with the PS&E submission.

All plans and computations shall be signed and sealed by a Professional Engineer registered in the State of Maryland.

IV. CONTRACT DRAWINGS

A. Preliminary Reports

Preliminary Reports shall be submitted as stipulated in the General Instructions Section. Reports shall include a map (1" = 200') of the entire drainage area showing the proposed and existing storm drains. Also included shall be a flow tabulation and a preliminary estimate of project costs.

B. Contract Drawings

Storm drain contract drawings shall be prepared separate from other utilities. The drawing numbers of plans of other utilities being prepared at the same time shall be shown. Manhole numbers, job orders, and contract numbers shall be obtained from the Department of Public Works. The Sample Drawing illustrates these applications.

All applicable items shown on the Check List shall be clearly shown on the Contract Drawings and one (1) copy of the Check List shall be submitted along with the Final Contract Drawings, both signed and sealed by a professional engineer registered in the State of Maryland.

1. Plan

The plan shall be drawn on the upper half of the plan, north pointing toward the top or left side of the sheet.

a. Scale

The scale shall be 1"=50', 1"=40', 1"=30', or 1"=20'. The scale shall match the roadway plan scale.

b. Method of Indicating Location

Generally, drains, inlets and manholes shall be located in plan by centerline road stations and offsets or dimensions from property markers or other well defined physical features. Curb radii shall be shown for inlet location purposes. However, in areas where physical features are not available, coordinates of manholes and bearings of storm drains based on the Harford County Coordinate System shall be used.

Contours shall be provided at all yard inlets, at the inlet and outlet of roadway culverts, and at all outfall locations.

c. Easements

Easements shall be provided along side and rear lot lines. The minimum width easement for a side yard shall be seven and one half feet (7 ½') for a combined width of fifteen feet (15') where two yards abut. The minimum width for a rear yard easement shall be ten feet (10') for a combined width of twenty feet where rear yards abut.

Where an easement contains a stormdrain pipe, the minimum width shall be twenty feet (20'). This width shall be increased for easements containing water or sanitary lines, as well as a storm drain line, to a minimum of thirty five feet (35'). Where necessary, due to excessive depth of a storm drain line, the easement width shall be increased as directed by the Department of Public Works.

2. Profile

a. Scale

The scale of the drain profile and inlet profiles shall be 1" = 50' horizontal, 1" = 5' vertical.

b. Street Grades

Approved established grade shall be obtained from the Department of Public Works. When such grades are not available, they shall be established by the design engineer and submitted to the Department of Public Works, for approval. The established grade shall be centerline, where available.

Where drain is located in present or proposed pavement or shoulders the existing centerline grade of road shall be shown. Where drain is outside pavement or shoulders, existing ground over drain shall be shown. If the Drain is to be constructed on fill, profile of the undisturbed earth (at drain location) shall be shown.

The top elevation and type of all inlets, manholes, and other drainage appurtenances shall be shown in the structure schedule. These elevations shall be computed from the established grade and shown to the hundredths.

c. Hydraulic Gradient

A hydraulic gradient shall be shown for storm drains and open channels.

d. Notes

Profiles shall note existing and proposed grades of conduits, size, type, class, length, slope, upstream and downstream inverts, design storm discharge, full flow and partial flow velocity, slope of the hydraulic gradient and, where applicable, normal depth of flow.

3. All Existing and Proposed Utilities

All existing and proposed utilities shall be accurately and clearly shown in plan and profile according to the Standard Symbols in the General Instructions Section.

4. Location and Design Information

A Drainage Area Map shall be shown indicating the entire drainage area to be served by the proposed drainage system (current and future), scale 1" = 200'. The Drainage Area Map shall include existing, proposed, as well as, future drainage systems. Where the drainage area map will not show at least two (2) well known streets or routes a Location Map shall be added (1" = 2000') showing the location of the work. Design Data, Bench Marks, based on Harford County Coordinate System, manhole and inlets schedules shall be shown on the Sample Drawing and as listed in the Check List.

5. Special Details

Structures or details not included in the Standard Details shall be clearly detailed on the Contract drawings.

6. Structure Schedule

A structure schedule shall be provided on the Contract drawings. It shall note the type of structure, its designation on the plan, the Standard Detail reference or the location of detail within the drawings, top elevation, and inverts in and out of the structure.

Separate structure schedules shall be provided for SHA, County and private structures.

C. Estimate of Quantities

The Engineer shall submit an estimate of quantities for each contract, including contingent items.

D. Design Calculations

Design Engineers shall submit design data and computations for the project as specified in the General Instructions Section. The data shall be submitted at the same time the Contract Drawings are submitted for review and shall include but not be limited to the following items:

1. Hydraulic Design

- a. Flow Tabulation Form
- b. Calculation of Stormdrain, Ditches, Culvert, Hydraulic Gradient, etc.

2. Structural Design

- a. Drains

Structural calculations for all drains other than pipes shown in loading tables shall be submitted.

- b. Special Structures

Design computations for all special structures shall be submitted.

3. Coordinates

Bearings and distances shown shall be where coordinates are on contract drawings.

4. Results of Borings and Test Pits

Where information pertinent to design, such as borings, has been collected, this information shall be submitted to the Department of Public Works and shown on the plans.